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THE FRUIT TRADE.

THE last few years have witnessed a general tendency towards expansion in world production and consumption of fruit. Improvements in methods of cultivation, handling and marketing coupled with extensive publicity campaigns have played a large part in bringing this about. Modern theories of nutrition which attach great importance to the consumption of fruit have, through medical journals, the daily press and food advertisements also enhanced public interest in this aspect of dietetics.

Ample evidence of the growing volume of international trade in fruit is submitted in a report* recently issued by the Imperial Economic Committee and also in its annual survey† of fruit supplies in 1934. Perhaps the most striking facts disclosed are that the fruit industry has advanced not only since the war but also during the economic depression, witness the record consumption of fruit in the United Kingdom in 1934. Production figures are stated, on the other hand, to be scanty and in view of the rapid development in the output of certain fruits it is feared that the world's markets may shortly be unable to absorb all the available supplies. In the meantime, however, the fruit industry is undoubtedly enjoying a fair measure of prosperity both in foreign and Empire countries; it is particularly encouraging that tropical fruits grown in British territory have shared in this development.

For various reasons complete and reliable figures of production are difficult to come by. Thus, for several fruits, the increase in production since the war cannot be precisely stated. The increase has, nevertheless, been large, particularly in those countries where fruit is grown exclusively or mainly for export. Fruit could not altogether hope to escape the effects of the world depression but it does not appear to have suffered as severely as most primary products. The more reliable export figures tend to show upward trends especially in the case of citrus fruits, exports of which in 1933 were 30 per cent. higher than the average of the years 1927-31. Spain still provides more than half of the citrus total but other citrus producers are noticeably extending their shipments, in particular, Palestine, South Africa and

* Fruit. A Summary of Figures of Production and Trade. The Imperial Economic Committee. June 1935. *His Majesty's Stationery Office*, Adastral House, Kingsway, London, W.C.3. Price 1/- net.

† Fruit Supplies in 1934. Prepared by Intelligence Branch of the Imperial Economic Committee. *His Majesty's Stationery Office*. Price 1/6 net.

Brazil. Exports from Brazil have increased each year from 11 thousand tons in 1927 to 84 thousand tons in 1933. In the same period exports from South Africa rose from 25 thousand to 67 thousand tons and although the rise has not been so regular, exports from Palestine have increased from 92 thousand to 147 thousand tons. World trade in citrus fruit of all kinds increased from an average of about 1,300,000 tons in the period 1923-27 to over 2,000,000 tons in 1933. The international trade in apples and pears has also increased since the war but not at the same rate as that for oranges and bananas.

A feature of the past few years is the growth in exports recorded from Empire countries even where the world total seems more or less stationary or even declining. The Empire, as a whole, however, still remains a net importer of all important fruits with the exception, in normal years, of bananas. This is due to the heavy import of fruits into the United Kingdom and Canada. Nevertheless the dependence on foreign supplies is lessening. Thus in the banana trade Jamaica's exports to England have shown a rapid increase at the expense of those from foreign countries.

Among all importing countries, the United Kingdom is by far the most important, Germany comes next, while other European markets are also becoming more prominent as outlets for surplus fruit supplies. The United States, in view of her own large production does not import much fresh fruit, except bananas, of which her imports are by far the largest in the world, averaging annually about three times those of the United Kingdom.

Although the production of fruit in the United Kingdom is increasing, on an average about three-quarters of the supplies available for consumption come from overseas. In the past twenty-five years the trend of raw fruit imports has been consistently upward, and imports are now nearly twice as great as before the war, the average for the five years 1929-33 being well over 1¼ million tons as compared with less than three-quarter million tons in the period 1909-13. The bulk of the total is still supplied by foreign countries, imports from which are some 50 per cent. greater than in pre-war years, but a relatively much greater advance has been made by Empire countries, whose contributions in the five years 1929-33 averaged more than four times the pre-war quantity. In 1934 imports of raw fruit from Empire countries reached a new high level, representing nearly 46 per cent. of the total sources of supplies. Of the chief tropical fruits, imports of grapefruit, oranges and pineapples were all greater than those in any previous years while imports of bananas were only just short of the 1932 record. The imports of fresh fruit from the British West Indies were heavier than in any year except 1932 while those from South Africa and Palestine constituted new high records.

For a number of years there has also been a constant growth in the consumption of fresh fruit in the United Kingdom. Thus in the five years 1924-28, total available supplies averaged 1½ million tons annually. During the next five years the average was nearly 1¾ million tons and 1934 broke all records with 2 million tons. The apparent consumption per head was about 70 lb. in 1924, 88 lb. in 1933 and nearly 96 lb. in 1934, the latter record being mainly due to exceptionally heavy supplies of apples.

In view of the growing interest which has been displayed in the production of citrus fruits in the West Indies it is gratifying to find that the demand in 1934 for grapefruit and oranges has been greater than that in any previous year. Exports of grapefruit from the British West Indies in particular have shown a progressive rise. The trade in green limes, on the other hand, is still very small in comparison with that of lemons. There are other tropical fruits, however, to which attention might be paid with advantage. One would like, for instance, to see more detailed information on avocado pears, mangoes, granadillas, custard apples, papaws and other tropical fruits which in time might acquire commercial significance. Many of these fruits, for which there is room for expansion, could be grown in the West Indies. The avocado pear especially, offers not inconsiderable possibilities. Its importance as a food has already been realised in the United States where it is rapidly becoming a recognised article of diet. The chief obstacles to an increase in the trade of this and of other tropical fruits would appear to be uncertainty of marketing possibilities, technicalities involved in production and marketing and the capitalisation of the industry during the earlier stages. Much knowledge, however, has and is still being accumulated on various aspects of production and it is to be hoped that the passage of time will see a greater appreciation of the more select tropical fruits in the world's markets.

OFFICIAL STATISTICS.

There is to-day, both in public administration and in private enterprise, an increasing tendency to plan for the future in the light of the accumulated experience of the past. This tendency has not only invested with a new importance the collection and publication of statistical information on a very wide range of subjects; it has also emphasised the need for a directory of published material such as is afforded by the *Guide to Current Official Statistics*.

Prepared under the auspices of a permanent Committee of Departmental statisticians, this annual volume provides a comprehensive index to the extensive numerical data published each year in the form of official reports, returns, accounts and periodicals.

Volume XIII of this indispensable handbook has just been issued. It deals with the statistics published in 1934, contains 350 pages, and costs 1s. net, or by post 1s. 5*d*. It may be obtained direct from the sale offices of H.M. Stationery Office or through any book-seller.

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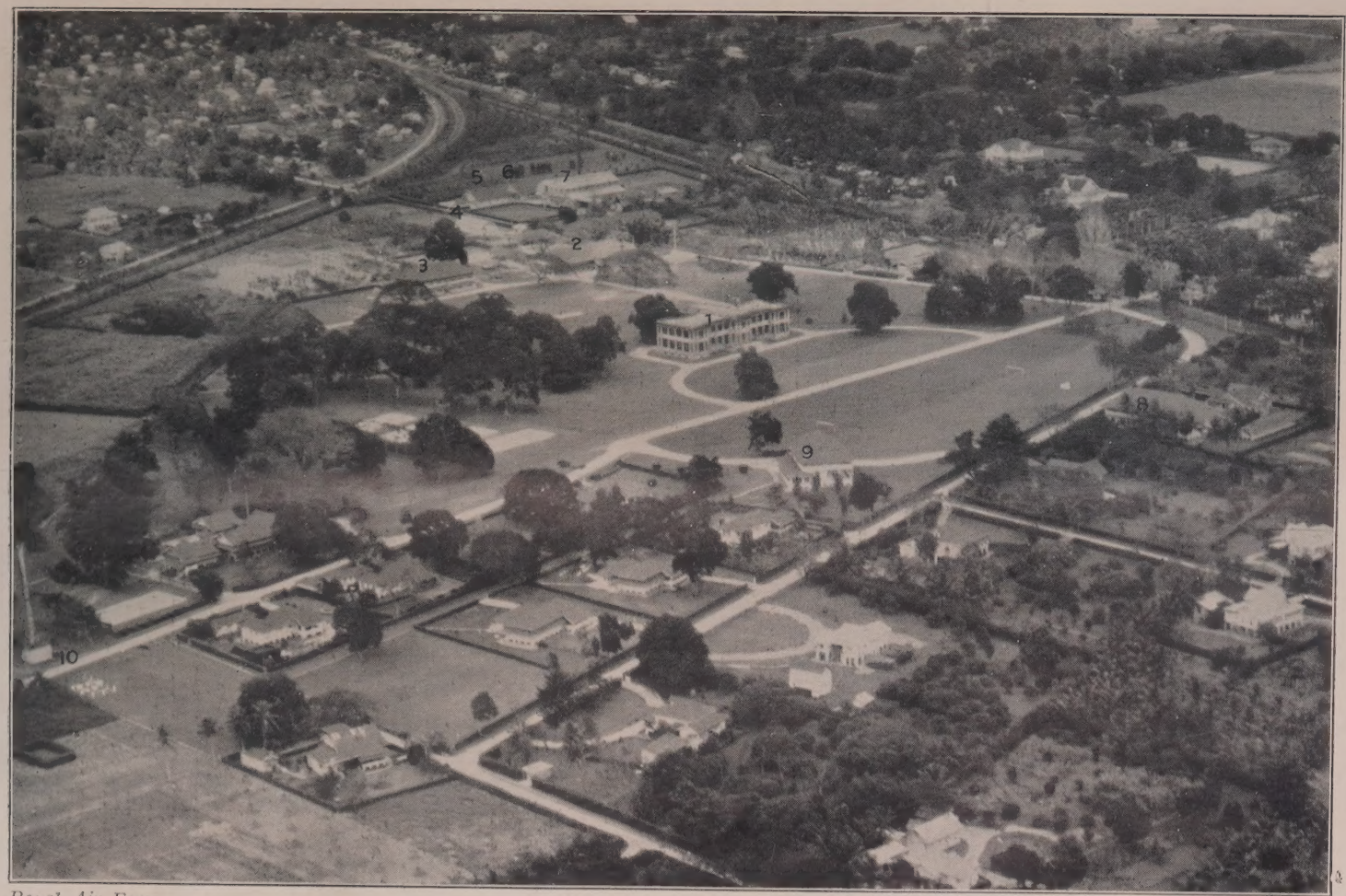

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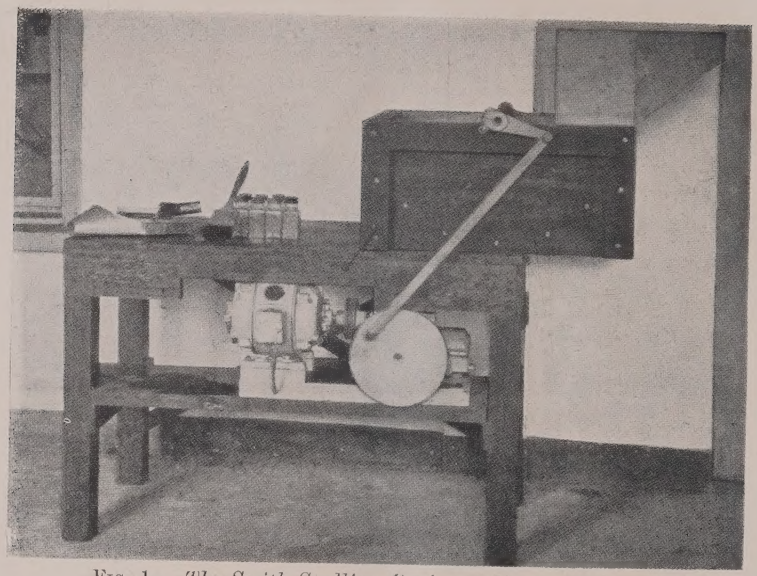

FIG. 1. *The Smith Shelling Device, ordinary position.*
(*See article on page 255.*)

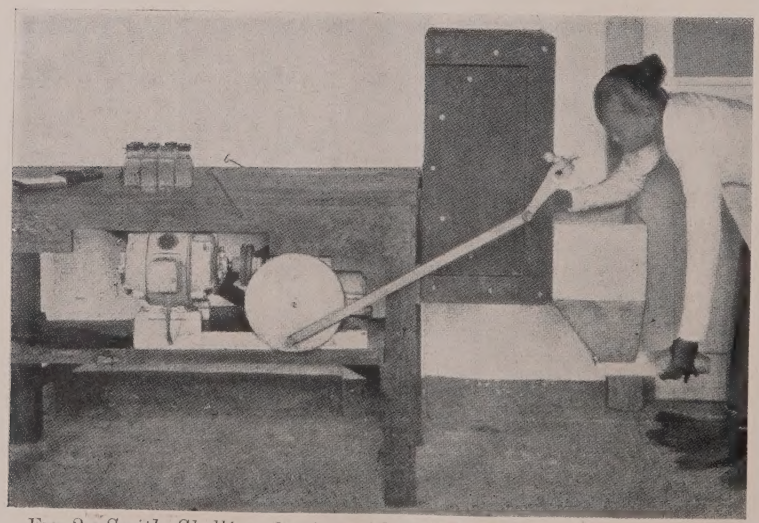

FIG. 2. *Smith Shelling Device with "Sheller" tilted over the end of the table.*

BREAKING OF RICE IN MILLING IN RELATION TO THE CONDITION OF THE PADDY.

By Gerold Stahel,
(*Agricultural Experiment Station, Surinam.*)

Introduction.

The quality of milled rice is judged largely by the percentage of whole grains which it contains. Breakage in milling is considerably influenced by the harvesting technique and it is obvious that accurate information regarding the interaction of these two factors should be of particular benefit to rice growers.

Skrivimankoti rice is the most common variety grown in Surinam. It is a long-grained Siam type, which is highly susceptible to breakage, the percentage of broken grains averaging 50 per cent., and in extreme cases being as high as 85 per cent. The Surinam rice mills, which number about 100, are small and equipped with simple Engelberg and Buffalo hullers. During the milling season, competition is very great and mills have to work at high pressure. Although better results are obtained through careful milling, this is seldom practiced, because of the extra expense and shortage of time.

The very high breakage of Surinam rice may be attributed chiefly to varietal characteristics and to unsuitable harvesting practices (9). During the period 1932-34 a critical examination was made of the various factors influencing the percentage breakage. It will be shown in the following report that current field practice can be considerably improved.

Working Methods.

All the milling tests were carried out by means of a "Smith shelling device" (5). This is used extensively in the United States, and has proved an excellent machine for experimental purposes (Plate, Fig. 1). It is both handier, and more efficient than the smallest type of huller available. For each milling test, which took only from three to four minutes, 50 grams of paddy were used. Before the sample of paddy was passed through the "sheller" it was mixed thoroughly three times in a "Boerner Sampler." The moisture test for which 50 grams of the same rice sample were used, was carried out in a "Brown Duvel Moisture Tester" (1).

The Smith "sheller" consists of a wooden base with a downward semi-circular curved surface and a rubbing block with a curved lower surface. Both curved surfaces are covered with leather. When the machine is in use the rubbing block is pulled backwards and forwards over the curved surface of the base. During a test, two assistants provided with brushes rub off the rice left hanging at the spots where the block reverses. The hulls are removed by tilting the "sheller" over the end of the table (Plate, Fig. 2), to which it is hinged, and by brushing the contents into a pan through the hopper which is fastened at the base. In the United States, the loose hulls after shelling are separated from the grains in a Bates laboratory aspirator, a rather expensive apparatus. In Surinam, this is done just as accurately, but much more cheaply by Javanese women provided with tampas or flat bamboo baskets.

The Smith "sheller" is equipped with an automatic cut-off switch, which stops the action of the block after any given number of rubs for which it is set. This arrangement was not used in this particular investigation. The time needed for milling differs widely according to the varieties of rice used, and according to their moisture content. In the experiments, the motor was stopped when the last grain of paddy was shelled, the precise moment at which this takes place can be judged easily.

Throughout the experiment, only those grains that had lost not more than the point of endosperm on the embryo were considered as whole rice.

Correlation between the Moisture Content of Paddy and Breakage in Milling.

In the United States, Italy and probably other countries outside the tropics, rice is milled when its moisture content is about 14 per cent. In Surinam, the rice is stored with a moisture content of about 14 per cent., but if it were milled at this stage, without further drying, the breakage would be very high. Thus all rice mills in Surinam are provided with drying floors where the paddy is dried in the sun for several hours before it is milled. When dry enough—a stage which natives test by cracking some grains between their teeth—the water content is from 10 to 11 per cent. The paddy is next put into heaps and not milled until the rice has cooled to air temperature. Overnight, the heaps are covered with empty bags or with a tarpaulin. If the paddy is milled immediately after having been dried in the sun, *i.e.*, when it is still warm, many grains will break.

By 1930, W. D. Smith and W. M. Hurst had already determined the percentage breakage of Blue Rose, Early Prolific, Stormproof and Fortuna rice with samples taken during the drying in a commercial rice drier. The observations were discontinued when the moisture content fell to 14 per cent. and the rice was milled. The graph given by Smith and Hurst shows clearly that, at least for Stormproof and Fortuna, the maximum percentage of whole grains was not yet reached at this moisture content (6).

M. Kondo and T. Okamura discovered in 1929 that the hardness of rice in Japan increases during natural drying under shade, and that after about three weeks this remains constant. They omitted, unfortunately, to determine the moisture content at which maximum hardness was recorded (3).

The writer studied the correlation between moisture content and breakage with eleven Surinam rice varieties. Each variety was

harvested with a moisture percentage of 20 to 24 per cent. and dried on separate frames in the sun. From time to time, during the drying, samples were taken and mixed in a Boerner Sampler. From each sample two portions, each 50 grams, were weighed and put in separate flasks. The contents of one of these flasks were analysed on the same day in the Brown Duvel Moisture Tester. The contents of the second, however, were not shelled before next morning, when the distribution of the moisture in the grains was again in equilibrium.

The curves (Text figs. 3 and 4) show that in all eleven varieties the weight of whole grain per 100 grams of paddy reaches a steady high value at a moisture content of 10 to 11 per cent. Otherwise the curves differ (8), and from these, three groups may be distinguished.

1. *The Vary Lava Group.*—(Vary Lava, Lady Wright) with the highest milling qualities. With a moisture content of 17 per cent., the percentage of whole grains in the sample is about 65, (reckoned on paddy, not on rice). Subsequently, the percentage of whole grains increases very slowly up to 80 at 10 per cent. moisture content, when the maximum is attained. These varieties may be milled at 14 per cent. water content with only a few per cents below the maximum percentage of whole grains.

2. *The Baok Group.*—(Baok, Giliran, Boeloe poetih, Witte Wanica) or intermediate group. The curves rise in straight lines up to steady high values of between 69 and 75 at 10 per cent. moisture content. At 17 per cent. moisture content the percentage of whole grains is 50 to 55.

3. *The Skrivimankoti Group.*—(Skrivimankoti, Rexora, Padi Tjina, Kretek, Demerara No. 79) to which belong all the commercial rice varieties in Surinam. These are more or less of the long-grained type and are all easily threshed. The curves rise steeply up to steady high values of between 57 and 68 at 10 per cent. moisture content. At 17 per cent. moisture content, the percentage of whole grains ranges from 2 to 30. These varieties must be dried to 10 to 11 per cent. to give a sufficient percentage of whole grains.

Breakage in Milling in Relation to the Age of Rice at Harvesting Time.

The breakage in milling also depends on the age of the rice. To study this factor sawahs* as uniform as possible were selected, on which 10 sticks were placed at regular intervals. Round these sticks every day or every other day, a definite number of panicles were cut. After threshing, the paddy was mixed thoroughly in a Boerner Sampler and dried in the sun to below 10 per cent.

With green rice, a considerable proportion is broken in milling, but this diminishes as the rice ripens. It will be seen from text figs. 5 and 6 that the curves for whole grains reach their maxima simultaneously with the top curves representing the total amounts of rice shelled, *i.e.*, whole *plus* broken grains. Subsequently the top curves remain constant but those for whole grains show a marked decline coincident with a decrease in moisture content. It will be noted that the whole grain curves begin to fall when the percentage moisture content is between 17 and 20 per cent. at 10 to 11 a.m.

In 1933 when the dry season was normal the optimum harvesting period lasted only one week as the rice dried quickly but in 1934 which was abnormally wet the optimum period lasted three weeks. The rice dried slowly and the percentage moisture content declined only after three weeks to below 17 to 20 per cent. (10 a.m.), (text figs. 5 to 8).

It will be observed that the curves shown in figs. 7 and 8 dip temporarily in the regions of their maxima. This fall in values was probably due to a temporary depression of the moisture content below the critical point, followed by a series of days with a higher average humidity. The return to the maximum after a fall in values was never observed with harvested and threshed rice though moistened for several days.

Sun Cracks.

If dry paddy is left over-night out of doors or gets moistened by any other means it takes up water and fine cross-wise cracks appear in the grain. Such cracks are visible shortly after the water content of the paddy rises, and eventually remain when the rice is finally dried. They are responsible for most of the breakage in milling, and it is therefore important to know the conditions which lead to their formation. Before 1930 it was generally accepted that these cracks were due to rapid drying in the sun (2), hence the name sun cracks. This, however, is not so. When paddy is suddenly dried in a thin layer in the sun to below 10 per cent. no sun cracks are formed. This was proved by putting paddy dried in this way in a sealed flask when no cracks developed. On the other hand a similar sample left in moist air very soon showed severe sun cracking.

Kondo and Okamura discovered in 1930 that moistening of dry paddy results in cracking of the grains. The drier the paddy, the greater and quicker was the formation of cracks after a rise in moisture content (4). Although unaware of these investigations, the writer came to the same conclusions in 1932. Kondo and Okamura counted the grains directly after having shelled the paddy by hand. The writer did not make a direct count of the cracked grains, but deduced the proportion from resultant breakage when the grains were shelled in the Smith "sheller."

The exact point at which sun cracking begins after remoistening dried rice was next determined. For this experiment rice harvested with a moisture content of 20 to 24 per cent. at 10 or 11 a.m. was used. Of every one of the seven varieties tested, 6 kg. of paddy were taken. After careful mixing the paddy was spread in a thin layer over about 20 frames and dried in the sun. From time to

* Plots.

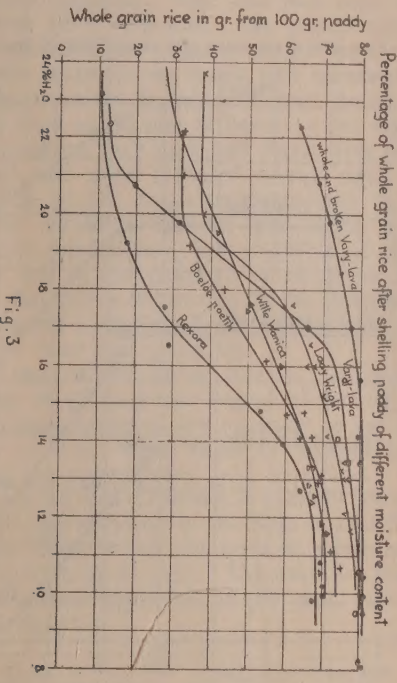
Whole grain rice in gr. from 100 gr. paddy
Percentage of whole grain rice after shelling paddy of different moisture content
whole and broken Very Local
Local Light
Local Heavy
White Jeerige
Bearded Heavy
Rexora

Fig. 3

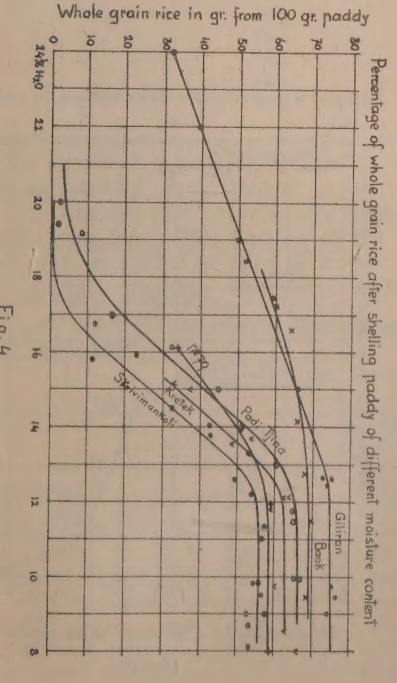

Fig. 4

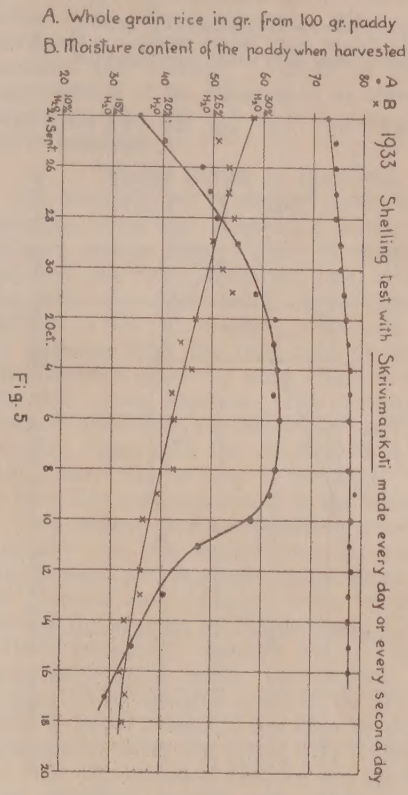
A. Whole grain rice in gr. from 100 gr. paddy
B. Moisture content of the paddy when harvested
1933 Shelling test with Skrivimankoti made every day or every second day

Fig. 5

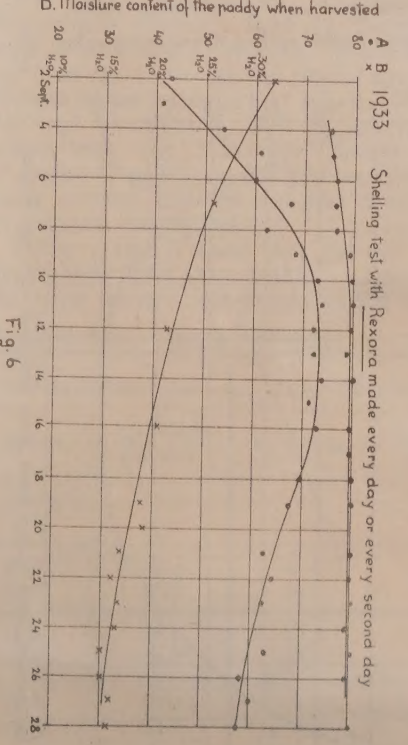
A. Whole grain rice in gr. from 100 gr. paddy
B. Moisture content of the paddy when harvested
1933 Shelling test with Rexora made every day or every second day

Fig. 6

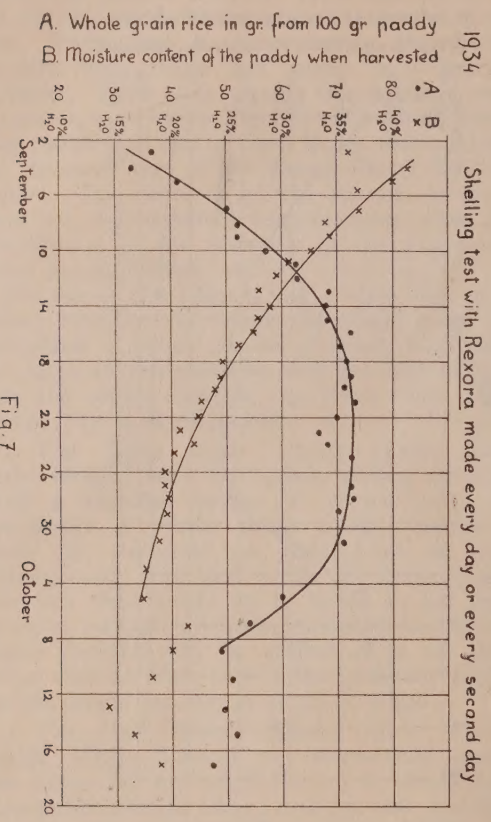
A. Whole grain rice in gr. from 100 gr. paddy
B. Moisture content of the paddy when harvested
1934
Shelling test with Rexora made every day or every second day
September
October

Fig. 7

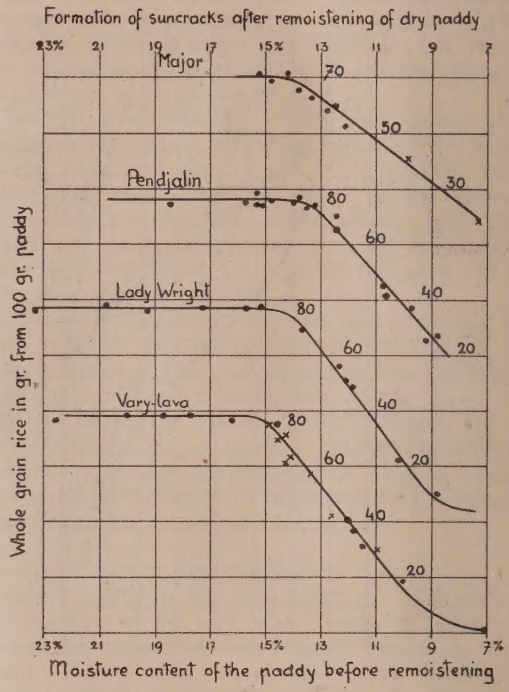
Formation of suncracks after remoistening of dry paddy
Major
Pendjalin
Lady Wright
Vary-lava
Whole grain rice in gr. from 100 gr. paddy
Moisture content of the paddy before remoistening

Fig. 9

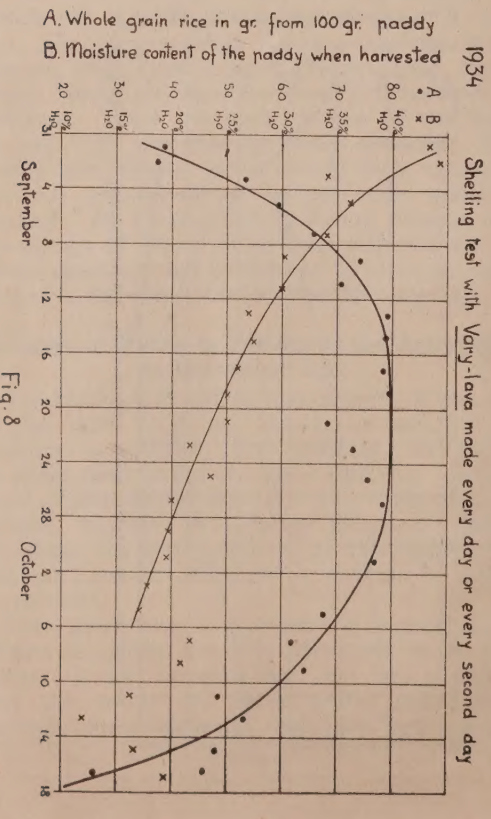
A. Whole grain rice in gr. from 100 gr. paddy
B. Moisture content of the paddy when harvested
1934
Shelling test with Vary-lava made every day or every second day
September
October

Fig. 8

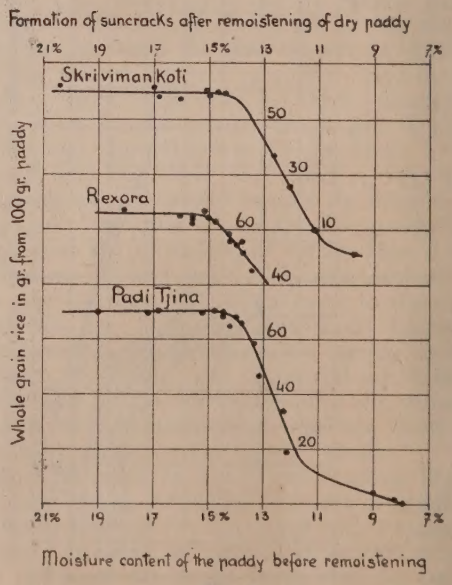
Formation of suncracks after remoistening of dry paddy
Skriviman Koti
Rexora
Padi Tjina
Whole grain rice in gr. from 100 gr. paddy
Moisture content of the paddy before remoistening

Fig. 10

time during the drying, the paddy on the frames was thoroughly turned over, 50 grams were used for a water analysis. The rest was kept in a closed flask till 7 or 8 p.m. The paddy samples of different moisture content were then put in basins with water for 1½ hours, and subsequently spread again on the frames and dried during the following days in the sun to below 10 per cent.

The curves for Vary Lava and Major were partly completed with data collected several days later with paddy of the same ripeness (text fig. 9). When the moisture content was from 15 to 24 per cent. remoistening had no influence on the breakage, but in rice dried to 14 to 15 per cent. moisture the curves began to fall, the steepest fall being recorded with Padi Tjina and the least steep with Major (text figs. 9 and 10).

It has been shown above that in the field the percentage of whole grains begins to decline with the moisture content as low as 17 to 20 per cent. at 10 to 11 a.m. This seems to contradict the results of the experiments just described. The main reason for this difference is that the moisture content of rice standing in the field is about 4 to 5 per cent. lower in the afternoon of a dry, sunny day, than at 10 or 11 a.m.. The data for Rexora rice on a sunny day with 97 per cent. sunshine were as follows :—

Time.	Moisture Content.
8 a.m.	20.9 per cent.
10 ,, ...	20.2 ,,
12 noon	18.6 ,,
1 p.m.	19.2 ,,
2 ,, ...	18.4 ,,
3 ,, ...	16.2 ,,
4 ,, ...	15.2 ,,
5 ,, ...	18.4 ,,
6 ,, ...	18.0 ,,

From the results it is certain that paddy to be stored should not be dried below 14 per cent. unless it is to be kept in a hermetically closed silo or a similar container. The paddies of the Vary Lava group can be milled at once at 14 per cent. moisture content, whereas the paddies of the Skrivimankoti group have to be dried immediately before milling to 10 per cent. After milling, this rice takes up water again from moist air and thus becomes sun cracked. Cracks in milled rice, however, are of no importance as once shelling is completed they do not lead to any substantial rise in breakage.

Paddy Drying in the Field.

The best method of drying paddy after it has been harvested and threshed is to spread it on a proper drying floor. This method, however, requires too much transport and labour and is therefore uneconomic and impracticable for the farmers of the rice districts, who have to harvest 1½ hectares with the help only of their family. Such farmers generally use a sickle to harvest the rice and straw together. The produce is subsequently spread on the harvest ground to dry and remains there until the whole field is completed, which may take as long as ten days. The paddy is then threshed and stored in the house.

This method was compared to two others. In one the rice was bound into sheaves, three of which were put in stooks in the same manner as in Europe and America with wheat. In the second the sheaves were leant against "Heinzen" which essentially consists of a framework of horizontal laths some two metres in length supported on uprights stuck in the ground. This kind of frame is used in the Alps for drying wheat and grass. Over the upper lath a sheaf is hung, so that the standing sheaves are partly covered and protected against rain, while a draught is ensured.

For these experiments Skrivimankoti and Rexora were selected. Each day the sheaves of a stook, a heap from a "Heinzen" and a corresponding quantity of rice spread on the ground, were brought to the laboratory at 1 p.m. The rice was threshed immediately and an average sample taken with the "Boerner Sampler." With 50 grams of paddy an analysis was made of the water content, and the rest was dried to below 10 per cent. and shelled.

Tables I and II show that the rice spread on the stubbles dried very quickly. After three days the water content was already as low as 12.6 per

Table I.—Harvesting Records with Skrivimankoti Rice.—(28-9-34—6-10-34.)

	Spread on the Stubbles		Upright in Sheaves.		On "Heinzen".	
	% Water.	% Whole Grains.	% Water.	% Whole Grains.	% Water.	% Whole Grains.
September 29th ..	18.6	59.0	22.0	60.8	2.5	60.2
do. 30 h ..	—	—	—	—	—	—
October 1st ..	12.6	30.0	16.8	62.4	20.8	58.4
do. 2nd ..	9.1	17.2	13.3	58.6	19.6	5[illegible].0
October 3rd ..	12.1	10.4	13.8	48.0	20.5	60.2
do. 4th ..	13.0	11.6	13.2	54.2	18.8	60.6
October 5th ..	11.2	17.0	14.6	57.0	17.3	58.2
do. 6th ..	10.7	8.8	14.2	54.6	17.7	57.6

Table II.—Harvesting Records with Rexora Rice.—(28-9-34—6-10-34.)

	Spread on the Stubbles		Upright in Sheaves.		On "Heinzen".	
	% Water.	% Whole Grains.	% Water.	% Whole Grains.	% Water.	% Whole Grains.
September 29th ..	17.9	58.6	22.9	67.2	25.2	66.6
do. 30th ..	—	—	—	—	—	—
October 1st ..	12.6	42.2	18.4	68.6	24.0	65.0
do. 2nd ..	10.6	36.6	16.5	65.8	22.0	63.8
October 3rd ..	13.0	24.8	16.9	64.6	22.4	67.4
do. 4th ..	12.2	21.4	14.4	67.2	20.4	—
October 5th ..	11.2	27.8	14.6	68.4	20.4	66.6
do. 6th ..	—	—	14.4	63.0	19.3	67.0

cent. at 1 p.m., thus 2 to 2½ per cent. below the critical point for sun cracking. This fact is clearly demonstrated by the sudden decrease in percentage of whole grains due to remoistening during the night. After the first three days this percentage is only half that for Skrivimankoti and two-thirds for Rexora, compared with the original percentage. During the following days the percentage of whole grains decreased further, especially with Skrivimankoti.

Different results were obtained with the sheaves standing in stooks in the field. The rice here dried more slowly, so that there was practically no decrease even after eight days in the percentage of whole grains in either variety.

With the covered sheaves of the "Heinzen," the drying was so slight that over a period of eight days the moisture content remained far above the critical point for sun cracking but also above that for safe storage. Consequently the percentage of whole grains remained unchanged.

It is evident therefore, that the method of drying commonly used in Surinam is detrimental to good milling. If the harvested product is not left longer than two days on the stubbles, the drying will be quick and efficient; but a longer period will cause a heavy cracking of the grains.

The results with the sheaves standing in the field were so satisfactory that these tests will be repeated on a larger scale, and also, it is hoped, under more normal weather conditions.

Summary.

The various factors that influence the breakage of rice in milling were examined experimentally with the aid of the Smith Shelling Device, the Boerner Sampler and the Brown Duvel Moisture Tester. The results proved that :—

(*a*) The optimum moisture content for milling is 10.5 per cent. or less. This is particularly important in varieties like the Skrivimankoti group which are very susceptible to breakage.

(*b*) As regards maturity of the crop at harvest, there is an optimum period of from one to three weeks at which the rice should be cut to give the best milling sample. Within the limits quoted the drier the season the shorter will this optimum harvesting period be.

(*c*) If dry paddy is re-moistened, sun cracks develop and these always cause a much higher breakage in milling. The term 'sun crack' is a misnomer as the cracks are not due to rapid drying in the sun but to a rise in moisture content. The critical point at which re-moistening produces these sun cracks is 14 per cent., so that paddy to be stored should never be allowed to dry out beyond this level. Sun cracks produced after milling are not deleterious.

(*d*) In Surinam the grain and straw generally harvested together with the hand sickle, and the produce is left in the field on the stubbles to dry. It was shown that if this drying period exceeds two days, the moisture content of the rice falls below the critical level of 14 per cent. moisture, and high breakage in milling will result. This can be avoided by drying in stooks in the field. If this practice is followed the drying period in the field may be extended from eight to ten days without or with but little detriment to the milling quality.

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REVIEW.

THE SOYA BEAN.

By Elizabeth Bowbidge. *Oxford University Press*, London, 1935. pp. 83, 6s.

This little book is intended to bring to the notice of the British farming community an alternative and very promising leguminous crop —the Soya Bean. This legume has been known and cultivated for over 5,000 years in the Far East, where it is looked upon as one of the most valuable of Nature's gifts to man. It is only since the beginning of the present century that it has taken any important place among the commercial crops of the Western Hemisphere, but already it has become one of the staple crops of the U.S.A., where the area cultivated per annum has increased, in the last 25 years, from 2,000 to some 5,000,000 acres. In the pre-war period, sporadic attempts were made to mature the crop in England, without much success, and gave rise to the general impression that the crop was not one suited to the English climate. Since then, largely as the result of the careful research of one man—Mr. J. L. North—extending over an 18-year period, four varieties of Soya Bean eminently suited to English conditions have been isolated. These varieties are markedly different in their botanical and cultural characters and give the British farmer a choice of growing this legume as a vegetable, an oilseed, a green manure, or a forage crop.

Within the limits of existing knowledge, the proper cultural technique is described, from the preparation of the seed bed to the threshing of the harvested produce. One of the points emphasised is the need for inoculation of the seed whenever it is being introduced into a new locality. The process is a comparatively simple one and has the advantage that it does not require to be repeated with succeeding crops grown on the same land. Another feature that appears to be important is the selection of the individual variety best suited to any particular soil and climate. Experience in the East has shown that relatively slight changes in environment necessitate a change in variety. The areas suggested as suitable for Soya Bean cultivation in England are the south-east and midland counties; the north and west are thought to be too cold or too wet for any of the four strains at present on the market.

The last two chapters describe briefly the many ways in which the crop may be utilised, and demonstrate effectively the reason of its rapid rise in popularity in recent years. It is a short season crop, yet yields may exceed a ton of seed per acre. The oil from this seed is of excellent quality and may be used for light or lubrication, in the manufacture of soaps, paints, and even explosives, or as an edible oil in various ways. The dried beans may be manufactured into a large variety of different foodstuffs ranging from milk powders to coffee or soup substitutes. The green beans are an excellent vegetable. The plant is a soil improver and is sometimes grown as a green manure crop. The residues from the farm and manufacturing processes are nearly all valuable as oil meals, cattle cakes or roughages. The Soya Bean appears to approach the farmer's ideal crop—the universal provider.

As an introduction to Soya Bean cultivation in England, the book is an undoubted success. It is written in non-technical language, and should appeal to the practical man for whom it has been compiled. No salient feature of the crop has been omitted, yet the book is commendably brief. The author admits that further research under English conditions is necessary before the true economic value of this legume can be assessed, but the prospects as outlined in the text, appear good enough to attract the attention of the pioneers among the farming community, and should encourage them to give this much needed alternative crop a trial in their rotation.

D. D. P.

AGRICULTURAL NOTE BOOK.

Copies of Professor Wood's "Note-Book of Tropical Agriculture" (price 5 shillings) may be obtained on application to the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

RECENT INVESTIGATIONS ON SUGAR-CANE AND SUGAR-CANE SOILS IN TRINIDAD.

I.—General Effects of Ground Limestone.

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Introduction.

The present paper deals with information obtained on sugar cane and sugar-cane soils in recent years as a result of field experiments with ground limestone in Trinidad. Accounts of earlier studies of this nature by the author have been published in the *Journal of Agricultural Science* (1), *Soil Science* (2), *the Empire Journal of Experimental Agriculture* (3), *the Proceedings of the Agricultural Society of Trinidad and Tobago* (4) and the *Proceedings of the Sugar-cane Investigation Committee of Trinidad.*

Conclusions of practical importance resulting from the earlier investigations, and relevant to this paper, may be summarised as follows :—

(1) On certain areas in which sugar cane was severely damaged by froghopper attack, the increase in yield of the first crop of plant canes, reaped after a dressing of ground limestone equal to the lime requirement, more than paid for the cost of the limestone (4). Any residual effect of the lime on the yield of subsequent crops therefore constituted clear profit.

(2) On areas in which sugar cane was not damaged by froghopper attack, the increase in yield of the first two crops of cane was not large enough to pay for the cost of a dressing equal to the lime requirement, but there was good reason to believe that the beneficial effect of the limestone would persist over a number of crops (3).

(3) Greater immediate financial gain results in general from dressings of ground limestone equal to half the lime requirement of the soil than from dressings equal to the full lime requirement (4).

(4) Over-liming can cause a significant fall in yield, but the fall occurs only in the presence of applied nitrogen. Such a depression in yield is associated with lack of balance in manurial treatment, and can be remedied by supplying the deficient nutrient (3).

(5) Ground limestone can give superior results to slaked lime on clay soils (1).

The method used for measurement of the lime requirement is based on the degree of unsaturation of the soil with lime (2). It has been tested by experiments in the field and shown to be reliable (3).

At the time of publication of the earlier investigations the following problems remained unanswered :—

(1) The length of time taken under normal conditions (*i.e.* in the absence of froghopper damage) for the gain in yield, resulting from liming to the lime requirement, to pay for the cost of the dressing of limestone.

(2) The length of time over which the beneficial effects of liming on yield persist, and the rate of loss of lime from sugar-cane soils.

(3) The extent to which the beneficial effects of lime are influenced by the grade of limestone used, by the presence of other manures, and by weather conditions.

(4) The effects of dressings of ground limestone on the quality of sugar-cane juice.

These problems have been under study in a series of experiments laid down on three characteristic soil types :—

(*a*) A one-time swamp-and-lagoon clay.
(*b*) A very heavy, ' red-weathering ' clay.
(*c*) A degenerated loam.

Immediate and Residual Effects of Finely Ground Limestone on a Swamp-and-Lagoon Clay.

Data which give a measure of the continued effect on yield of a single dressing to the acre of ten tons of ground limestone (the lime requirement

Table I.— *Immediate and residual effects of a single dressing of finely divided limestone on yield* (1930-34).
Dressing of limestone in 1930.—Ten tons to the acre (the lime requirement of the soil).
Grade of limestone.—65-70 per cent. through 100 mesh B.S. sieve.
Soil type.—Swamp-and-lagoon clay (Caroni).
Variety of cane.—B.H. 10 (12).

Expt.	Ground limestone per acre (1930)	Yield (tons cane per acre). Plant canes (1930-32)	First ratoons (1932-33)	Second ratoons (1933-34)	Gain in yield (tons per acre). Plant canes (1932)	First ratoons (1933)	Second ratoons (1934)	Total to date (1930-34)
I ..	10 tons	36.05	42.26	26.30	..	..	..	..
	Nil ..	29.90	36.52	20.53	6.15	5.74	5.77	17.66
II ..	10 tons	43.40	26.70	18.94	..	..	..	..
	Nil	36.58	19.23	12.85	6.82	7.47	6.09	20.38
III ..	10 tons ..	39.51	33.20	24.25	..	..	..	..
	Nil ..	31.56	26.86	18.15	7.95	6.34	6.10	20.39
I, II & III..	Average gain				6.97	6.52	5.99	19.48

of the soil) are recorded in Table I. Some 65 to 70 per cent. of the limestone passed through a 100 mesh B.S. sieve. This is the finest grade of limestone available in quantity in Trinidad. The experiment is laid down on a swamp-and-lagoon clay.

There are 32 replicates of the limed and unlimed plots in Experiment I, which is laid down in the form of Latin squares. Experiments II and III are laid down in the form of randomised blocks. There are 16 replicates of the limed and of the unlimed plots in Experiment II and 64 replicates of each in Experiment III. The plot size is 1/15 acre. Full details of the layouts of the three experiments are recorded elsewhere (5).

The soil of the experimental areas contains 1 per cent. coarse sand, 30 per cent. fine sand, 34 per cent. silt and 33 per cent. clay.

The ground limestone was forked into the soil after ploughing and before planting.

The Yield Data for the First Crop-Series (1930-34).

In all three experiments the dressing of ground limestone equal to the lime requirement gave an immediate gain in yield of plant canes which averaged 6.97 tons to the acre. The dressing had an average residual effect on the yield of the first ratoons amounting to 6.52 tons of cane to the acre, and on the second ratoons amounting to 5.99 tons of cane to the acre. The immediate and both residual gains might be due to chance far less than once in 100 times.

The total gain in yield to the acre for the first three crops reaped after applying the limestone was 19.48 tons, on the average for the three experiments. *This gain has paid for the cost of the limestone and of its application.* Further, the data in Table I provide no indication that the residual effect of the limestone has begun seriously to diminish with time.

The average yield of second ratoon-canes on the unlimed plots of the three experiments was 17.18 tons to the acre. The corresponding yield on the limed plots was 23.16 tons. A third ratoon-crop could therefore have been reaped from the limed plots with profit. The data in Table I provide confirmatory evidence that treatment of the soil with ground limestone can materially improve the ratooning power of sugar-cane.

The gains in yield due to the dressing of 10 tons of ground limestone in Experiment I were smaller than in Experiments II and III. All the plots of Experiment I were given a basal dressing of inorganic manures as plant canes and as first and second ratoon-canes. It will be shown in the second paper of this series that the presence of inorganic manures in certain combinations can seriously diminish the gain in yield due to lime.

The Lime Status of the Experimental Plots in 1934.

The plots of the three experiments were carefully sampled for analysis in 1934, *i.e.*, after the second ratoon canes had been reaped and four years after dressing with ground limestone. The plots which were limed in 1930 were found to contain 0.338 per cent. exchangeable calcium measured as CaO, and the unlimed plots 0.209 per cent. The difference of 60 per cent. in favour of the former plots is statistically significant and might be due to chance far less than once in 100 times. *The dressing of ten tons of ground limestone in these experiments not only increased the yield of the first three crops of cane by 19½ tons to the acre, but, in addition, has very greatly raised the lime status of the soil.* The additional exchangeable lime in the limed plots is almost certain to lead to future increases in yield, and to an appreciable improvement in the tilth and general condition of the soil.

The average pH value of the unlimed plots in 1934 was 5.7. The corresponding pH value for the limed plots was 7.1. Analysis proved the limed plots to contain free calcium carbonate (Table II). Four years after its application the ground limestone had not completely acted on the soil. This is to be expected, for it has been shown in a previous publication (2) that complete interaction of calcium carbonate with the soil has not occurred even in the naturally calcareous soils of Trinidad. Also, the dressing contained a certain amount of coarsely ground material.

The dressing of 10 tons of limestone to the acre was lightly forked into the soil in 1930. The distribution of the free limestone in the soil with depth, shortly before the experimental area was reploughed in 1934, is therefore a matter of interest. Average values for individual measurements made on the soil samples taken from all plots of the three experiments are recorded in Table II.

Table II.—*Distribution of ground limestone with depth of soil four years after application.*

Depth of soil.	Free limestone in soil (per cent.)			
	Exp. I.	Exp. II.	Exp. III.	Av.
0- 6 ins. ..	0.17	0.33	0.35	0.28
6-12 ,, ..	0.09	0.09	0.18	0.12
12-18 ,, ..	0.04	0.06	0.09	0.06

Footnote—Data are available for the distribution of limestone with depth in the soil rather less than two years after the application of the dressing. These data were obtained from a liming experiment laid down in the form of three 4 × 4 Latin squares on the swamp-and-lagoon clay. All the plots were given a basal dressing to the acre of five tons of limestone. Some 65 per cent. of the limestone passed through a 100 mesh B.S. sieve. The limestone was lightly forked into the soil.

Depth of Soil.	Free limestone in soil (per cent.)	Percentage of total.
0- 3 ins.	0.26	24
3- 6 ,,	0.31	28
6- 9 ,,	0.22	20
9-12 ,,	0.18	15
12-18 ,,	0.15	14

In this experiment 49 per cent. of the limestone had penetrated to a depth greater than six inches and 14 per cent. to a depth greater than one foot, within two years.

Approximately 40 per cent. of the ground limestone which remained free in the soil had been washed by rain to a depth greater than six inches, and 13 per cent. to a depth greater than one foot.

Residual Effect of Ground Limestone on the Second Crop-Series.

The three experimental areas were reploughed and replanted in 1934, the plot positions being carefully preserved. Growth measurements made on the young plant canes of Experiment III, when four months old, are set out in Table III.

Table III.—*Residual effect of finely divided limestone on growth of plant canes of* 1934-36 *crop (swamp-and-lagoon clay).*

Experiment III.
Age of plant canes. Four months.

Plot treatment.	Shoots per stool* (1935).	Height of tallest shoot* (1935).
Limed (1930) ..	10.37	59.21 cms.
Unlimed ..	7.34	52.28 cms.
Net difference ..	3.03	6.93 cms.
Percentage diff.	41	13

* Mean values for 64 plots.

The growth on the limed plots was significantly superior to that on the unlimed plots. The differences were clearly obvious to the eye at the time of measurement. It appears probable that the ground limestone applied in 1930 will have a very appreciable residual effect on the yield of plant canes to be reaped in 1936.

It is of interest that the effect of the dressing of ground limestone on early 'bunching' (*i.e.*, number of shoots to the stool) is proportionately much greater than on the length of the shoots.

The data which have been recorded prove the value of ground limestone, 65 to 70 per cent. of which passes through a 100 mesh B.S. sieve, and give precise information as to its early beneficial effects.

Immediate and Residual Effects of Coarse Limestone on a Heavy 'Red-Weathering' Clay.

Data which give a measure of the continued effect on yield of single dressings of 10 tons, 20 tons (the lime requirement) and 30 tons of ground limestone to the acre are set out in Table IV. Only 35 per cent. of the limestone passed through a 100 mesh B.S. sieve. The experiment is laid down on the red-weathering-clay soil type of the Naparima District.

Experiment IV is laid down on an undulating site, unevenly intersected by hills and valleys, and typical of the red-weathering-clay soil type. The layout is in the form of three 8 × 8 Latin squares, with two replicates of each liming treatment in the rows and columns. The columns of the squares are detached and staggered in a manner such as to avoid as far as possible the major irregularities of the area. The plot size is 1/10 acre.

The soil of experimental area contains 3 per cent. coarse sand, 6 per cent. fine sand, 21 per cent. silt and 65 per cent. clay. The area was given an average basal dressing of 10 tons of pen manure to the acre in 1929 and in 1933. Basal dressings of inorganic manures were applied to all plots in 1933 and 1934.

The soil was cultivated by chiselling both before and after the application of the ground limestone.

The Yield Data for the First Crop-Series (1929-33).

In this experiment liming gave an immediate and significant gain in yield of the first crop of plant canes, which increased with the size of the dressing of limestone. The average initial gain of 6.62 tons of cane to the acre in Experiment IV is comparable with that obtained in Experiments I, II and III. The red-weathering-clay soil of the Naparima District is therefore capable of giving as large an immediate response in yield to limestone as the swamp-and-lagoon soil of the experiments previously described.

Table IV.— *Immediate and residual effects of increasing single dressings of coarse limestone on yield* (1929-35).
Dressings of limestone in 1929.—Nil, 10 tons, 20 tons (the lime requirement) and 30 tons to the acre.
Grade of limestone.—35 per cent. through 100 mesh B.S. sieve.
Soil type.—Red-weathering clay (Naparima District).
Variety of cane.—B.H. 10(12).

Experiment IV.

Ground limestone per acre (1929).	Yield (tons cane per acre).				Gain in yield (tons per acre).				
	Plant canes (1929-31)	First ratoons (1931-32)	Second ratoons (1932-33)	Plant canes (1933-35)	Plant canes (1931)	First ratoons (1932)	Second ratoons (1933)	Plant canes (1935)	Total to date (1931-35)
Nil ..	36.03	22.12	10.93	21.76	..	..	..	..	..
10 tons ..	41.74	24.65	14.23	23.13	5.71	2.53	3.30	1.37	12.91
20 tons ..	42.77	24.09	14.69	22.22	6.74	1.97	3.76	0.46	12.93
30 tons ..	43.44	25.27	15.32	23.49	7.41	3.15	4.39	1.73	16.68
Average gain					6.62	2.55	3.82	1.19	14.18

The first and second residual gains in yield in Experiment IV averaged to the acre 2.55 and 3.82 tons, respectively, in comparison with 6.52 tons and 5.99 tons for Experiments I, II and III. In Experiment IV, therefore, the gains were not maintained at their original high level throughout the first crop-series, as in Experiments I, II and III. The total average gain for the first crop of plant canes and for the first and second ratoons in Experiment IV was consequently only 12.99 tons to the acre. The corresponding gain in Experiments I, II and III was 19.48 tons of cane. *The average gain for the first crop-series in Experiment IV was not large enough to pay for the cost of the lightest dressing of limestone.*

It seems probable that the small residual gains in Experiment IV were due to the use of a comparatively coarse grade of limestone, for the large initial gain in yield suggests that the soil type and the method of incorporation of the limestone in the soil were not important contributory factors. The small residual gains in yield cannot be attributed to weather conditions which, during the period 1931-33, were almost identical for the areas on which Experiments I, II, III and IV were laid down.

In 1929, coarse limestone (35 per cent. passing through a 100 mesh B.S. sieve) was the only form of limestone generally available in quantity for manurial purposes in Trinidad. It is largely as a result of the researches of the Sugar-cane Investigation Committee that a finer grade of limestone is now generally available.

The experimental area was rechiselled and replanted in 1933. The residual effects of the dressings of ground limestone on the 1933-35 crop of plant canes are discussed later in this paper.

pH Value and Lime Status of the Experimental Plots (1929-33).

Data for Experiment IV which give a measure of the effect of the various dressings of limestone on the pH value of the soil during the period 1929-33 are recorded in Table V.

Table V.— *Increase in pH value of soil with time, in relation to size of dressing of ground limestone (red-weathering clay).*

Dressing of ground limestone in 1929.	pH value of the soil.		
	1931	1932	1933
Nil	6.01	6.00	6.16
10 tons	7.02	7.11	7.19
20 tons	7.29	7.41	7.41
30 tons	7.33	7.43	7.43

Each of the figures set out in Table V is a mean value for measurements made on 48 soil samples, which were taken from the various plots to the depth of one foot after the plant canes, the first ratoons and the second ratoons had been reaped.

The dressing of ten tons of ground limestone to the acre increased the pH value of the heavy clay soil from 6 to 7, *i.e.*, reduced the concentration of hydrogen ions in the soil to one-tenth of its original value. A further but smaller rise in pH value resulted from the dressing of 20 tons to the acre (the lime requirement). Increasing the dressing above the lime requirement had little additional effect. The recorded effects of liming on the pH value of the soil might be due to chance less than once in 100 times.

The major change in pH value on this heavy soil, which contains 65 per cent. clay, occurred within two years of the application of the limestone, *i.e.*, during the period 1929-31, whether the dressing applied was large or small. A further, but minor increase in pH value took place during the third year (1931-32), but after the third year there is no evidence of continued upward change.

It is of interest that the diminution in the gain in yield of cane due to liming during the years 1932 and 1933 is not accompanied by a corresponding fall in the pH value of the soil.

The average amounts of free limestone present in the top foot of soil of the plots of Experiment IV, four years after the application of the dressing, are set out in Table VI.

Table VI.— *Amount of free limestone present in top foot of soil, four years after application (Experiment IV).*

Dressing of coarse limestone (1929).	Free limestone in top foot of soil (1933)*.
10 tons per acre ..	0.36 per cent.
20 tons per acre ..	1.27 per cent.
30 tons per acre ..	2.24 per cent.

* Mean values for 48 plots.

The quantity of free limestone in the top foot of soil increases significantly with the size of the dressing. All the limed plots still contained comparatively large reserves of unused limestone in 1933.

The average amount of free limestone in the top foot of soil in Experiments I, II and III was 0.20 per cent., four years after applying the dressing of 10 tons to the acre. Some 65 to 70 per cent. of the limestone used in these three experiments passed through a 100 mesh sieve. In Experiment IV the top foot of soil contained as much as 0.36 per cent. of free limestone, four years after dressing the soil with 10 tons to the acre. Only 35 per cent. of the limestone used in this experiment passed through a 100 mesh sieve. The very marked contrast between the large residual gains in yield resulting from liming in Experiments I, II and III, and the small residual gains in Experiment IV, may therefore be explained by the greater availability of the finer grade of limestone used in Experiments I, II and III.

It is sometimes stated that the coarser particles present in ground limestone can weather and break down very rapidly under tropical conditions, but the author's experience does not lend confirmation to this view. Under the particular conditions,

which obtain in the sugar-cane areas of Trinidad it appears essential to use finely divided limestone if immediate, continued and paying returns are to be obtained.

Immediate and Residual Effects of Coarse Limestone on a Degenerated Loam.

Another set of data which give a measure of the continued effect on yield of increasing dressings of ground limestone are recorded in Table VII. Thirty-five per cent. of the limestone passed through a 100 mesh B.S. sieve. The site of this experiment is a degenerated loam, *i.e.*, a loam which as a result of its earlier treatment has lost its original characters and acquired new and inferior set of properties.

The soil of the experimental area was in poor condition and had been leached almost to a state of exhaustion at the time the experiment was laid down. The experimental area was formerly in the hands of peasants and previous to 1929 had never been adequately drained or tilled.

The layout of the experiment is in the form of three 8 x 8 Latin squares, with two replicates of each liming treatment in the rows and columns. The plot size is 1/10 acre.

The soil of the area contains 3 per cent. coarse sand, 37 per cent. fine sand, 27 per cent. silt and 22 per cent. clay. The area was given an average basal dressing of 10 tons of pen manure to the acre in 1929 and 1933.

The ground limestone was applied to the plots before ploughing. Gaps were left between the plots to allow for any carry-over of the lime.

The Yield Data for the First Crop-Series (1929-33).

The results obtained in Experiment V on the degenerated loam differ fundamentally from those obtained in the experiments on the swamp-and-lagoon soil and the red-weathering clay, *for on the degenerated loam the beneficial effect of liming increased with time over the first crop-series.* In Experiment V the average immediate gain to the acre of 1.79 tons of plant canes (1931) was very small. The gain of 3.80 tons for the first ratoons (1932) was somewhat larger. The gain of 4.52 tons for the second ratoons (1933) approaches the immediate gain for the first crop of plant canes in the experiments on the two other soil types. The immediate and both residual gains for the first crop-series in Experiment V are statistically significant.

The results recorded for Experiment V are probably characteristic of the type of response to lime which is likely to occur on degenerated soils which previously have been unsatisfactorily drained and tilled. It is doubtful whether areas of this nature should be included in a liming programme if maximum immediate returns are desired.

The average gain in yield to the acre of 10.11 tons of cane for the first three crops in Experiment V has not paid for the lightest dressing of limestone. The use of a coarse grade of limestone and the condition of the soil are probably associated with this comparatively small total for the crop-series.

Dressings of sulphate of ammonia were given to the first and second ratoons on certain plots in Experiment V. It is noteworthy that in the presence of nitrogen, *alone*, the yields for both crops rise to a maximum at the lime requirement and then significantly fall, as the dressing of limestone is increased.

In 1932 the second ratoons in Experiment V were subject to froghopper blight over a small and isolated area which included each of the four liming treatments. On the unlimed plot the canes made slow recovery. On the most heavily limed plot recovery was somewhat more rapid. Recovery was excellent on the plots which had been limed to 8 tons to the acre (half the lime requirement) and to 16 tons to the acre (the lime requirement). The contrast between the former two plots and the latter two plots was sufficiently marked at the time for the plot boundaries to be sharply defined and to be distinguishable at a distance. Dressings of ground limestone can lead

Table VII.— *Immediate and residual effects of increasing single dressings of coarse limestone on yield* (1929-35).
Dressings of limestone in 1929.—Nil, 8 tons, 16 tons (the lime requirement) and 24 tons to the acre.
Grade of limestone.—35 per cent. through 100 mesh B.S. sieve.
Soil type.—Degenerated loam (Couva District).
Variety of cane.—1929-33, B. 156. 1933-35, B.H. 10(12).

Experiment V.

Ground limestone per acre (1929).	Yield (tons cane per acre).				Gain in yield (tons per acre).				
	Plant canes (1929-31)	First ratoons (1931-32)	Second ratoons (1932-33)	Plant canes (1933-35)	Plant canes (1931)	First ratoons (1932)	Second ratoons (1933)	Plant canes (1935)	Total to date (1931-35)
Nil ..	34.58	35.70	14.07	27.13	..	..	..	..	
8 tons ..	35.88	39.25	17.82	28.36	1.30	3.55	3.75	1.23	9.83
16 tons ..	36.26	40.25	19.56	28.89	1.68	4.55	5.49	1.76	13.48
24 tons ..	36.98	39.00	18.38	29.58	2.40	3.30	4.31	2.45	12.46
Average gain					1.79	3.80	4.52	1.81	11.92

to gains in yield and aid in the recovery of sugar cane from froghopper blight. Liming to great excess, however, appears to limit both beneficial effects.

The experimental area was reploughed and replanted in 1933.

LIME STATUS OF THE EXPERIMENTAL PLOTS (1933).

The average amounts of ground limestone present in the top foot of soil of the plots of Experiment V are set out in Table VIII. The soil samples were taken shortly before reploughing in 1933.

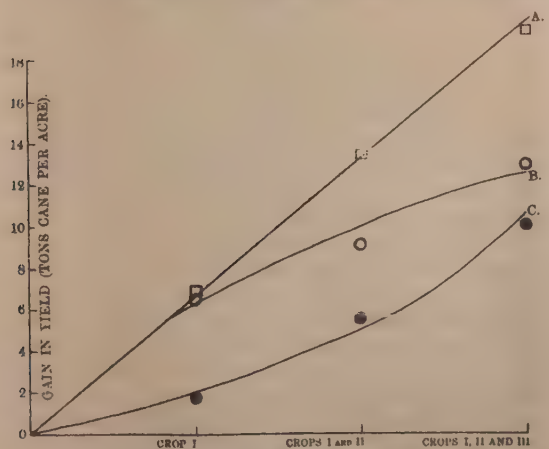
TABLE VIII.—*Amount of ground limestone present in top foot of soil, four years after application (Experiment V).*

Dressing of coarse limestone (1929).	Free limestone in top foot of soil (1933)*.
8 tons per acre ..	0.42 per cent.
16 tons per acre ..	1.07 per cent.
24 tons per acre ..	2.07 per cent.

* Mean values for 48 plots.

The data in Table VIII confirm those recorded in Table VI. The quantity of free limestone in the top foot of soil increases significantly with the size of the dressing. All the limed plots still contained in 1933 large reserves of unused limestone, which probably consist in the main of the coarser fractions of the material used.

Of the two grades of limestone used in the various experiments described in this paper, approximately half as much failed to pass through a 100 mesh sieve in Experiments I, II and III as in Experiments III and IV. Four years after application, approximately half as much limestone remained free in the soil in the plots dressed with ten tons to the acre in Experiments I, II and III as in the plots dressed with eight or ten tons to the acre in Experiments IV and V. These data suggest that it is necessary for ground limestone to pass through a sieve of approximately 100 mesh if it is to react with reasonable speed on the soil.



Total gains in yield due to a single dressing of ground limestone over a crop series of plant canes, first ratoons and second ratoons.

A. 65-70% limestone through 100 mesh B.S. Sieve (curve of unchanged returns).
B. 35% limestone through 100 mesh B.S. Sieve (curve of diminishing returns).
C. 35% limestone through 100 mesh B.S. Sieve on a degenerated soil (curve of increasing returns).

Residual Effect of Coarse Limestone on the Second Crop-series under Weather Conditions Unfavourable for Good Growth.

EXPERIMENTS IV AND V.

It is difficult intimately to mix ground limestone with the soil by a single ploughing. Mixing should be much more thorough after a second ploughing. A comparative increase in the residual gain in yield due to limestone might therefore be expected for 1933-35 crop of plant canes in the experiments laid down on the red-weathering clay soil and on the degenerated loam. Such a gain was not obtained. On the red-weathering clay the residual effect of the dressings of limestone averaged 1.19 tons of plant canes to the acre in 1935 (Table IV). On the degenerated loam it averaged 1.81 tons of plant canes in 1935 (Table VII). Both gains in yield, although statistically significant are smaller than those recorded for the corresponding second ratoon-crops reaped two years earlier.

These very unsatisfactory results may be ascribed to two possible causes. The rapidly available fraction of the coarse limestone may have become almost exhausted. On the other hand, very unfavourable weather conditions prevailed during growth of the 1933-35 crop of plant canes. During the last few months of 1933 the rainfall was unusually heavy. During 1934 a drought of exceptional severity and length was experienced. The prolonged wet weather, followed by the prolonged drought, may have set a check to any residual beneficial effects from the dressings of limestone.

The yield data recorded in Table IX for a liming experiment laid down on an alluvial soil in 1933 are of interest in the latter respect.

TABLE IX.—*Immediate effect of ground limestone on yield under unfavourable weather conditions* (1933-35).
Dressing of limestone in 1933.—5 tons to the acre.
Grade of limestone.—60 per cent. through a 100 mesh B.S. sieve.
Soil type.—River alluvium.
Variety of cane.—B.H. 10(12).

EXPERIMENT VI.

Dressing of limestone per acre (1933)	5 tons	Nil
Yield of plant canes per acre (1935)	22.21 tons	20.50 tons
Gain per acre	1.71 tons cane	

This experiment is laid down in the form of randomised blocks. There are 36 replicates of each liming treatment. The plot size is 1/20 acre.

The gain in yield of 1.71 tons is sub-normal for the grade of limestone applied. It seems possible, therefore, that the unfavourable weather conditions which prevailed during the crop period 1933-35 set a low limit to the gain in yield which can result from liming, apart from the fineness of division of the material employed.

Measurements of the influence of other manures on the gain in yield due to liming, of the rate of loss of lime from sugar-cane soils and of the effect of dressings of limestone on juice quality, will be published in later papers of this series.

A quinhydrone electrode was used to make the measurements of pH value recorded in this paper.

Summary.

(1) An account is given of the effects over a period of years of single dressings of ground limestone on the yield of sugar-cane and on sugar-cane soils. The data were obtained from experiments laid down in the field on characteristic soil types.

(2) Three fundamentally different classes of result in relation to the continued effect of ground limestone on yield are recorded. It is shown that:—

(i) A dressing of 10 tons to the acre of finely divided limestone (the lime requirement) to a swamp-and-lagoon clay, increased the yield of the first crop-series of sugar-cane by 19½ tons to the acre. This gain was divided approximately equally between the plant canes, the first ratoons and the second ratoons. It has paid for the cost of the limestone. In addition the lime status of the soil has been very greatly improved by the dressing and there is good reason to believe that its beneficial effect will persist over a number of future crops. The recorded data prove the value of finely divided limestone.

(ii) Dressings of 10 tons, 20 tons (the lime requirement) and 30 tons to the acre of coarser limestone to a red-weathering clay, increased the yield of the first crop-series on the average by 13 tons of cane, a gain which did not pay for the lightest dressing of limestone. The coarser limestone gave a large immediate gain in yield of plant canes but the residual gains for the ratoon crops were small. It is possible that this type of response to liming is characteristic for coarser grades of limestone.

(iii) On a degenerated soil, dressings of limestone gave a very small gain in yield of plant canes, a somewhat larger gain for the first ratoons, and a still larger gain for the second ratoons. A result of this nature is believed to characterise the effect of lime on soils which are in poor condition and which previously have never been adequately drained and tilled.

(3) Evidence is provided which suggests that if weather conditions are unfavourable for good growth, a low limit is set to the gain which can result from liming, apart from the state of division of the limestone used.

(4) Data are recorded which give a measure under natural conditions of the rate of interaction of ground limestone with the soil as determined by pH value, and of the distribution of ground limestone in the soil with depth, four years after application.

(5) It is shown that far greater quantities of limestone remain unused in the soil if a coarse grade rather than a fine grade of material is applied.

Acknowledgment.

The author wishes to acknowledge his indebtedness to Caroni, Ste. Madeleine and Waterloo Estates for their assistance and co-operation in the experiments described.

The data recorded in Tables I, II and III were obtained from experiments partly financed by Imperial Chemical Industries, Ltd.

Some of the data set out in Tables I, IV and VII have previously been published in the *Empire Journal of Experimental Agriculture* (3).

References.

(1) *Journal of Agricultural Science*, 1929, XIX, 26; 1929, XIX, 83.

(2) *Soil Science*, 1930, XXX, 349.

(3) *Empire Journal of Experimental Agriculture*, 1934, II, 78.

(4) *Proceedings of the Agricultural Society of Trinidad and Tobago*, 1933, XXXIII, 349.

(5) *Proceedings of the Sugar-cane Investigation Committee of Trinidad*, 1930, Part XVIII, 54, 1934, Vol. IV, 395.

THE CANNING OF GRAPEFRUIT.*

Grapefruit for canning is allowed to ripen on the trees, since under-ripe fruit or fruit which ripens after picking has a marked bitter flavour and the flesh is difficult to remove without breaking. The fruit is graded and then scalded in water at 206°F. to facilitate removal of the skins. It is yellow-peeled by hand, having been first cooled by water sprays on the peeling table for easier handling. The peeling is completed on the lye peeler, where it is sprayed above and below by a 1.5 to 2 per cent. solution of caustic soda slightly below boiling point for 10 to 15 seconds. The lye solution and particles of loose membrane are removed under strong sprays of water and the fruit passes to the segmenting operators *via* the drying fans. To remove the sections rapidly and unbroken is difficult work requiring considerable practice. In some factories lye peeling is not used at all, the entire work of peeling being done by hand. The cans are hand filled, the segments being packed close together to form a solid pack, 17 ozs. of fruit being packed into a No. 2 can. Sugar is added in syrup form at a density of 60° Brix. to the equivalent of 2 ozs. of sugar. Cans are usually sealed in a vacuum closing machine and sterilized at 180° to 190°F. for 40 minutes. The cans after sterilizing are immediately cooled in water. Plain cans are used instead of lacquered, hydrogen swells being found to develop more slowly in the former. The vitamin content of canned grapefruit is much the same as that of raw grapefruit.—(*Horticultural Abstracts*, Vol. V, No. 2, Abs. 312, p. 115, 1935.)

* By H. B. C. in *Food Manufacture*, Vol. X, pp. 113-14.

QUALITIES IN COTTON REQUIRED BY THE SPINNER.

By N. S. Pearse.

[*The following article is reproduced at the request of Mr. N. S. Pearse, General Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Association. It was originally presented in a form of a report to the International Cotton Congress, Milan—Rome.*—Ed.]

Introductory.

It has been my pleasure and privilege to visit the United States Cotton Belt upon several occasions, and frequently during each visit cotton farmers, landowners and others connected with the cotton-growing industry have asked the following question: "Say! What kind of cotton do you spinners really want?" In the case where the farmer has given the matter a little thought, he has jumped to the hasty conclusion that the world's spinners require their cotton to be of long staple, and the longer the better.

Occasionally, I have been asked to address meetings of cotton planters, and have explained to them the qualities the spinners desire in their cottons. As these addresses have usually been given at a moment's notice and without any preparation, I have not been able to do justice to this important subject. Therefore, it appears to me that a very useful purpose would be performed by stating clearly the exact qualities the spinner requires in his cottons, and that the information in the present paper should be distributed, not only to American cotton growers, but to the cotton cultivators in all cotton-growing countries. Needless to say, cotton shippers also may benefit from the views expressed herein.

It has often been said that the spinners have never indicated their requirements clearly, but it should be remembered that they are entirely out of touch with the grower, and information has to percolate through the broker, merchant, exporter and numerous other agencies before the spinners' views eventually reach the growers—that is, if they ever do. We do not expect the planter to understand the intricacies of cotton spinning—even a cotton merchant in Liverpool has been known to talk of "spinning" shirts—but I hope to explain in simple, non-technical language the qualities the spinner looks for in his cottons.

Staple.

There are, roughly speaking, five main classes of cotton spinning mills—thick, coarse, medium, medium fine, and fine. When asked to state the qualities of cotton required by the trade, a spinner in any of the above sections will immediately think of his own individual mill's requirements, but in the following table I have endeavoured to show the different growths each of the above sections will use.

	Length of Staple. Necessary.	*Origin of Cotton.*
Thick.	Below $\frac{1}{2}$ in.	Cotton Waste, Chinese, Short Indian, &c.
Coarse.	$\frac{1}{2}$ in. to $\frac{7}{8}$ in.	East Indian, Short American.
Medium.	$\frac{7}{8}$ to $1\frac{1}{16}$ in.	American, Brazilian, Peruvian, Egyptian Uppers, Pilion, &c.
Medium fine.	$1\frac{1}{16}$ in to $1\frac{3}{16}$ in.	Egyptian Uppers, Sakel, Brazilian, American, African, West Indian, Peruvian, Pilion.
Fine.	$1\frac{3}{16}$ in. and over	Sakel, East African, Tanguis, Sea Island.

The main bulk of the cotton consumed in the world's mills probably lies between $\frac{15}{16}$ in. and $1\frac{1}{8}$ in.—approximately 60 per cent. of the cotton produced to-day lies within these limits—no figures have been collected internationally to show the quantitative use of the different staples by the mills, and the above can only be estimated roughly.

Cotton growers should always keep in mind that a cotton with a short staple is of no use to the finer sections, but the coarser sections can use longer staple cottons than they usually find it expedient and profitable to put through their mills. Any cotton of a staple less than $\frac{3}{4}$ in. must necessarily compete with very cheap cotton-mill waste, and cotton planters cannot be urged too strongly to plant seed of such a quality as to produce a $\frac{7}{8}$ in. staple at the very least. In a dry season a $\frac{7}{8}$ in. staple seed will give much shorter lengths. Wherever possible, a seed which usually yields 1 in. staple is far more preferable, for cotton of $\frac{1}{8}$ in. up or down will always find a ready sale. Such cottons are termed "bread and butter" cottons by the spinners. The climate and other conditions in Egypt, the Anglo-Egyptian Sudan, East Africa, Brazil and Peru, are eminently suitable for the longer staple cottons in the quantity at present in demand by the mills for luxury goods during the present world depression, but where they can be profitably grown—that is, on good rich soils with a long growing season and with adequate moisture conditions—the cotton planter may find it more profitable to do so. However, he should realize that, owing to the longer growing season necessary for the maturing of long-staple cottons, his crop is exposed for a longer period to the vicissitudes of climate, plant disease and insect pests. Furthermore, the yield per acre is generally smaller than that of the shorter varieties.

Uniformity of Staple.

Perhaps the most important quality the spinner desires to find in his cotton is uniformity of staple —which factor is of paramount importance to the spinner. The ideal cotton, of course, in this respect would be one in which each and every fibre is of exactly the same length, as is the case with synthetic staple fibre such as artificial silk. Long-staple cotton with a large percentage of short fibres mixed into it is almost useless to the spinner, for the fine spinner is obliged to comb out all the short fibres, and he would call it a "wasty" cotton. The price he would pay for such a sample would naturally be lower in proportion to the amount of short fibres contained therein. Such a cotton would consequently have to be sold at a very much reduced price to coarser mills to compete with shorter staples—even so the coarse spinner would find it necessary to comb out the longer fibres. It is the *average* length of fibre in any pull during sampling that will indicate the value of the cotton—it is not the longest fibres in a sample which decide the value of a cotton in the spinner's estimation, for he will pull out the few long fibres and leave the average. The reason why Californian cotton is not used to a greater extent by European spinners is that it is generally lacking in this important quality, or, in other words, it is not "even-running." I believe this unevenness in staple is due to uneven irrigation in the fields, the higher parts of a field receive less water than others, with the result that in these parts the staple is shorter than that of the more copiously irrigated sections. If the cotton from the higher portions of the fields were kept separate this objection could easily be overcome.

False-packed or plated bales, with short cotton in the interior and the longer staple at the sides, are of course so strongly condemned by the spinners for this very reason of lack of uniformity in staple, but in this case the trouble is more serious, for the spinner cannot find the short staple in the drawn sample, as the shorter fibres are all in the centre of the bale. Should the short cotton be put into the machinery which has been set for the longer staple endless trouble will occur, due to broken yarn, bad spinning and weak yarn resulting in considerable waste, discontent among the operatives, loss in production, claims for poor yarn and loss of customers.

Irregular staple causes thick and thin places in the yarn and any unevenness in the thickness of the yarn imparts to the cloth a vari-coloured appearance when dyed. Breakage of yarn also caused by irregular staple brings about the same effect owing to the joints in the yarn.

Strength.

Strength of the individual fibres is the next most important quality in cotton desired by the spinners, for this quality obviously makes for a strong yarn and a strong cloth. The maximum strength in an individual fibre is only attained when the cotton boll is allowed to ripen fully; unripe fibres are immature and weak, and should a bunch of unripe fibres go through together into the yarn there would be a weak spot. Each bunch of unripe fibres shows up as a darker patch in dyed cloth for they absorb more dye than ripe cotton.

To the naked eye, individual cotton fibres appear alike, but under the microscope they appear as flattened tubes, with a number of kinks or convolutions running along their length, whilst these flattened tubes are twisted in some cottons more than in others. Some cottons also have more kinks than others, and are more suitable for certain yarns than a fibre with only a few. A sample of kinky cotton is what the spinner terms "rough," and is used for hosiery and blanket yarns, because it has a close resemblance to wool. The greater number of kinks or convolutions in a given length of fibre the greater will be the gripping power of each fibre to lap round and adhere to its neighbour in the yarn. But the number of kinks is not the only quality which makes for strength in yarn. There is the question of fineness. The finer or thinner each individual fibre is, the more fibres can the spinner twist into a cross-section of a certain diameter of yarn, and the more fibres there are in any given diameter, the stronger will be the yarn. It is therefore obvious that cotton-seed breeders and cotton planters should develop and grow types of cotton with finer fibres. Although it may seem paradoxical, thick or coarse-fibred cottons do not make for strength in yarn.

Uniformity.

Uniformity in the cotton, bale after bale, delivery after delivery, true to the original type should next be aimed at by cotton growers, and I may also say, by the exporters. This is a fault one often finds with cottons grown in new cotton-growing countries, where the crop is only produced in small quantities. One planter will grow one kind of cotton, his neighbour another; one planter is careful with his picking, whereas another may leave his picking until late in the season, with the result that the latter's cotton will contain a larger quantity of leaf, and at the same time will become stained by rains or frost. When once a spinner decides that a certain quality of cotton is suitable for the yarn he has to sell to his customers, he will readily prepare his machinery for such a cotton, providing he can be assured that he can always obtain that exact quality of cotton year in and year out. Unless he has this assurance, however, he will hesitate to alter his machinery to suit that cotton's staple, grade, strength and other qualities, for such alterations cause the spinner considerable inconvenience and monetary outlay. Egypt sells her cotton on "types" only, and is the outstanding example to be imitated in this respect.

Neps.

Absence of what the spinner terms "neps" is an essential feature of good cotton. A nep is a little bunch of immature or unripe fibres usually only noticeable when a thin film of the sample is held up to the light; they are about the size of a pin head. Another type of nep is produced on *saw gins* when the cotton is ginned too rapidly, or when damp seed cotton is passed through the gin. Small neps on the surface of cloth show up after dyeing much darker than the remainder of the fabric owing to the fact that neppy cotton absorbs the dye more readily than ripe cotton. Before the war it was the usual practice in the United States to store the seed cotton for 10 to 14 days before it was ginned, and thus it was given an opportunity to dry out. In the modern days of high speed, the cotton is usually ginned the same day that it is picked, with the result that cotton picked in the early morning dews shows considerable quantities of neps. Some authorities state that when the seed cotton is stored for 14 days the staple will absorb a small quantity of the oil from the seed and take on an improved silky appearance. Some also even maintain that the staple will actually grow in length during this period.

Colour.

The colour of the staple is of some importance. As a general rule, a white cotton is preferred, but in some cases butter-coloured, and even brown colours, are actually wanted, although the last mentioned have only a limited sale.

Grade.

Grade refers to the general colour of the sample, and the amount of leaf in it. The presence of a large amount of leaf naturally lowers the price of the cotton, as spinners cannot spin leaf and it is merely waste. It is therefore obvious that a spinner will pay less for a very leafy cotton. Then again, small quantities of leaf sometimes get carried right through into the resulting yarn and cloth, and must be removed before selling it to the customer. Leaf remaining in yarn after being woven into cloth causes an effect exactly opposite to that of nep. The leaf resists the dye or prevents the dye from coming into contact with the cotton beneath it. The leaf is afterwards removed, leaving white spots where each particle of leaf has been. The presence of other foreign matter, such as cotton stalks, straw, sand, cotton seeds, &c., should never be allowed, and the ginner who permits his machinery to become so dilapidated as to pass such impurities into the lint, should not have any cotton grower's custom. The bark from the stalk splits up into innumerable fibres, which cause great trouble by breaking down the ends in the spinning-room. Seeds cause further inconvenience in that they are broken up and carried forward in the yarn. These husks are very stiff, and should the yarn be used upon knitting machines, each seed mote will break a needle in the knitting machine, a most serious business for all concerned, and in the end the spinner will refuse to buy his cotton from the same source, which in its turn eventually has its effect upon the grower who produced that cotton.

Ginning.

The ginning of cotton is the first mechanical process through which cotton is passed, and I am sorry to say this process is often unsatisfactorily carried out. Of the two types of gins the saw gin is the one which can be more detrimental to the cotton fibre, whilst cotton of a staple longer than 1¼ ins. should never be saw ginned.

Bad ginning of cotton is a crime perpetrated upon the cotton grower usually without the latter's knowledge. Ginneries are only run during the picking season, and keen competition has made it necessary for the ginner to run as quickly and as long as he is able in order to obtain as full a production as possible. This practice of fast ginning absolutely ruins the cotton fibre. Such cotton is neppy, gin cut, *i.e.*, a large proportion of the fibres will be cut short—result: a wasty cotton for which the cotton planter will receive only a low price. There is a certain maximum speed of the saw gin most suitable for each length of staple which should never be exceeded. I may state here that the United States Government Experimental Ginning Station at Leland, Mississippi, is doing splendid pioneer work with the object of improving that country's ginning technique. It is to be hoped that the ginners throughout the Belt will adopt voluntarily the results of this station's experiments.

I have already mentioned that cotton should never be ginned when damp; neppy cotton will most certainly be the result.

Ginners should experiment for themselves as to what speeds suit the cotton of their district. Another point which should be noted is that the seed cotton should not be fed too rapidly to the breast roll, as this gives similar results to fast ginning.

Roller gins are highly satisfactory from the point of view of the quality of cotton they turn out, but as regards their output and supervision they are far and away behind the saw gin. There is a very real need for a roller gin where the seed cotton is fed to it pneumatically, but the difficulty in this respect is that the feed must be carefully regulated. There is scope here for the inventor, for each roller gin is fed by hand, and it is only possible to install them where labour is cheap.

Baling.

Cotton bales should be approximately of the same uniform weight, and should be sold on a net weight basis. Tare and bands also should be standardized. Cotton baled in a cotton covering would enjoy a readier sale among fine spinners than jute-covered cotton. Jute fibres mixed in with the cotton cause a very large percentage of the breaks in spinning. Spinners are now receiving large quantities of bales from Brazil, covered with a cheap, light, closely-woven cotton cloth, and this covering is proving eminently satisfactory, both during transportation and spinning.

Cotton Seed.

The means to be adopted by the new cotton-growing countries to improve cotton shipments can only be generally indicated in this paper, as individual study of the conditions of each country by an expert is necessary on the spot.

As a general rule, however, every new district should decide upon growing only one variety of cotton, in order to obviate the mixing of the seed at the gins and cross-pollination, with the resulting rapid deterioration of the seed and the quality of the cotton. The gins are usually—in fact, practically always—the cause of seed mixture, and gin-run seed should never be planted if the strain of a cotton is to be kept high, except in a "one-variety cotton community" or where a ginning factory gins only one type of cotton. Where this is impracticable the law should not allow the gin to sell cotton-seed for planting purposes, unless the gins are thoroughly cleaned out when a new variety is to be passed through the gin. In Egypt, where the seed supply is under the control of the Government, gins licensed to sell seed for planting purposes are taken entirely to pieces, and every seed lying in corners, bolt-holes, &c., in each gin and the conveyers is cleaned out before a new variety is passed through. The cleaning and examination of the gin is so thorough that the process reminds one of a search for deadly microbes or bacteria. Without exaggeration, the presence of one single seed of an inferior growth will do as much damage to a superior strain of seed when it is planted as any major cotton pest. The seed is the key to the supply of good cotton, and the Egyptian Government has only retained her position as a supplier of good cottons by means of the rigid control of her cotton-seed supply. A sample of every sack of cotton planting seed is examined by Government officials before being passed and certified as suitable for sale to the planter; all uncertified seed is used by the oil factories. That the seed supply of America should be left to individual firms, and above all to the ginners, is almost a crime, and is bound to lead to rapid seed degeneration. The State should own nucleus seed farms and ginning plants, and no other but Government grown and ginned seed should be used for planting purposes. The seed raised on the seed farms should then be passed on to competent planters and grown subject to Government inspection. The resulting cotton will naturally be ginned at the Government-controlled gins. This is one aspect of the situation which should not be treated from an individual point of view, as one single field of cotton from poor seed will lead to the ruin of the reputation of a whole county as a producer of high-class cotton, and frustrate the good intentions and endeavours of the rest of the community.

Price.

From the point of view of the grower, perhaps the most important factor is the question of price, and here I wish to take the opportunity of removing a serious misconception on the part of the average cotton grower. Certain growers I have met in America appear to labour under the impression that the spinner continuously desires low prices, and the lower the better. This is far from the truth. Prices fall when demand slackens. This decreased demand is a direct result of fewer yarn orders received by the spinner. Spinners actually prefer a steady market, or a steadily rising market. The grower who believes spinners want cotton prices to fall should remember that the spinner has far more capital invested in cotton yarn stocks than the average cotton planter has in cotton, and should cotton fall in price, spinners stand to lose far more money in the aggregate than the planters. I wish to stress the point that the spinners desire to see a prosperous cotton-growing industry, so that all concerned therein may be in a position to buy more cotton goods, and thus help to turn the wheels of finance and trade, with the ultimate object of increasing the consumption of cotton goods to the benefit of all concerned.

A NEW CURE FOR MALARIA.

Information has recently been received by the *Planters' Chronicle*, Vol. XXX, No. 12, on a comparatively new cure for malaria which though well known and in use in central and eastern Europe, appears to be practically unknown in the British Empire. There is at Arlesheim, Bei Basle, in Switzerland a clinic, by name Das Klinisch-Therapeutisches Institut, which is maintained by Dr. Ita Wegman, M.D., who has worked out a number of remarkable remedies, among which is a cure for malaria, even in its worst form—malignant tertian. There is a branch clinic in London under Dr. C. Nunhofer and Dr. Lawson at 10, Kent Terrace, Regents Park Road, London, N.W. 1.

The treatment is very simple, and in the case brought to the notice of our contemporary a cure has not only been effected but has rendered the patient immune though he has camped continuously in malarious districts since. It is stated that once cured immunity is assured for life. The treatment would appear well worth a thorough trial. The only drugs used are specially prepared concoctions of eucalyptus and copper sulphate. For mild cases, and as a preventive between fevers, they are taken internally, but for severe cases the eucalyptus can also be given as an injection. The copper sulphate preparation appears to have an almost immediate effect upon the fever, while the eucalyptus gives stamina to the blood which finally produces immunity. The specially prepared drugs are not costly and only have to be taken for from four to six weeks. Some years ago, this treatment was adopted by the Public Health Authorities in Belgrade, resulting in the population of that city and its suburbs becoming practically free from the severe seasonal malarial epidemics which were rampant in past years.

WEST INDIAN NOTES.

(Compiled by the Advisory Department, Imperial College of Tropical Agriculture.)

Sugar Industry.

The increased estimates for the 1935 crop, given early in the year as the result of better rainfall conditions at the end of 1934 and early in 1935, were in general justified by the actual final crop figures in the various Islands, Antigua being unfortunately a notable exception. In parts of Trinidad final yields were considerably in advance of expectations and at the Usine Ste. Madeleine a record crop of 46,737 tons was produced. Total production figures for the 1935 crop are given in the following table.

Island.	Tons of sugar.
Trinidad	117,780
Barbados	80,400*
St. Vincent	1,550†
St. Lucia	7,300
Antigua	17,288
St. Kitts	28,491

Towards the end of the reaping season Mr. J. G. Davies, Sugar Technologist to the Imperial College of Tropical Agriculture, visited St. Vincent at the request of the Commissioner of Agriculture to examine and report on the manufacturing conditions of the local industry. In respect of the syrup or fancy molasses industry he has submitted various suggestions for improving the quality and uniformity of this product. He also recommended the appointment of a full time officer to undertake the introduction of standard methods in the factories especially in the matter of chemical control.

In St. Lucia the substitution of ancient varieties of inferior type by B.H. 10/12, the introduction of better cultural methods and the general improved organisation of sugar-cane agriculture has been reflected in a steady and marked rise in yield of sugar per acre, and further marked increases will result in the near future from the improved conditions.

Interesting and useful results have been obtained from the experimental programmes laid down by the respective Sugar Cane Investigation Committees in Antigua and St. Kitts on the advice of Mr. P. E. Turner, Adviser in Sugar-cane Experiments to the Commissioner of Agriculture. The publication of a summary of these results is expected shortly.

In June Mr. H. E. Box, Entomologist to the Agricultural Advisory Department, made an extensive survey of cane fields in St. Kitts to determine the extent of the work of the recently introduced parasite (*Lixophaga diatraeae* Towns.) of the small moth borer (*Diatraea saccharalis* Fabr.). His report reveals that so far the introduction of *Lixophaga* into St. Kitts has been an outstanding success. He states that simultaneously with the progressive annual increase in parasitism there has been a steady decrease in borer infestation from 20.6 per cent. in 1932 and 20.9 per cent. in 1933 to 8.0 per cent. in 1935.

Mr. Box proceeded to Antigua in July where he conducted a corresponding survey. His findings in Antigua are very different from those in St. Kitts. Borer infestation has considerably increased within the last year and the parasite has completely disappeared in a great many areas and generally in the remaining areas the parasitism has been reduced to a very low figure. Mr. Box claims that there is evidence of some factor or factors, as yet undetermined, inhibiting the multiplication and spread of *Lixophaga* in Antigua. In view of the present status of *Lixophaga* in that island and of the fact in his opinion that a determination of its causes would entail the services of a full time Entomologist working on a carefully planned research programme (extending probably over several seasons), Mr. Box has recommended a trial introduction of another parasite of the moth borer, namely the Amazon fly (*Metagonistylum minense* Towns.). This recommendation has been approved and arrangements have been made from September onwards for a trial introduction of the Amazon fly into three selected localities in Antigua from St. Lucia, where its recent introduction and establishment has been a marked success in certain areas.

* * *

Sea Island Cotton Industry.

During recent months much interest has been displayed in Sea Island cotton by several important firms in the United Kingdom and in consequence much publicity has been given to Sea Island goods, especially shirts, underwear and hosiery. These trade activities have been reflected in a continued improvement in the Sea Island cotton market. Old stocks have completely disappeared and the bulk of the crops picked during the first half of the year has already been sold. Prices have mainly ranged between 1/3 and 1/5 per pound of lint in the United Kingdom, but a small quantity has also been sold at 1/6 per lb.

A trade mark for marketing cotton goods manufactured from 100 per cent. Sea Island cotton has been registered on behalf of the West Indian Sea Island Cotton Association and is now in operation.

* Includes fancy molasses equated to sugar.

† Not including fancy molasses.

Total production figures for those Islands which have already completed their crop in the present year and estimates of production of some others are given in the following table.

Island.	Production.—lb.
St. Vincent	173,735(1)
Barbados	40,801(2)
Montserrat	800,000(3)
St. Kitts	75,000(3)
Nevis	72,603
Anguilla	26,276(3)
Antigua	33,000

Weather conditions in Montserrat where a record acreage has been planted, have not been so favourable as last year, but present indications point to a very satisfactory yield per acre. The total crop is expected to be a little more than last year. In spite of prolonged dry conditions in May and June an average crop is expected in St. Kitts.

(1) Stains included 27,644. (2) Stains included 336 lb. (3) Estimates.

The cultivation of cotton has been started afresh on a small scale in the British Virgin Islands with seed furnished by the Department of Agriculture, Montserrat.

Fruit and Vegetable Industry.

The report of the first meeting of the Fruit and Vegetable Council (Eastern Group) has been published. The report contains much useful information relating to the fruit and vegetable industries in the Islands within the Eastern Group.

BANANAS.

The acreage under bananas is being rapidly extended and exports are increasing every month. An interesting annual report has been issued by the Chairman of the St. Vincent Banana Association at their first annual general meeting held in June, 1935. Also a comprehensive pamphlet on the cultivation of bananas for export has been prepared and published by the St. Lucia Department of Agriculture.

The export figures for bananas supplied by the Association to the Canadian Banana Company up to July, 1935, are set forth in the following table.

Bananas supplied by the Associations to the Canadian Banana Company up to July, 1935.

	Trinidad.	Grenada.	St. Vincent.[1]	St. Lucia.	Dominica.	Totals.
Nines	10,846	5,270	37	5,749	6,278	28,180
Eights	10,512	5,022	33	6,675	7,680	29,922
Sevens	12,494	5,561	44	6,891	8,977	33,967
Sixes	..	2,193	..	964	1,117	4,274
Total stems shipped ..	33,852	18,046	114	20,279	24,052	96,343
=Count bunches ..	24,977	12,365	83¾	14,441¼	16,805	68,671¾
Percentage of Counts	74%	69%	73%	71%	70%	71%
Price per Count bunch	60c.	58c.	58c.	58c.	58c.	..
Value	$ 14,986.20	$7,171.70	$ 48.72	$8,375.92	$9,746.90	$37,409.39
Total rejected ..	2,553	948	49	1,631	720	5,901

[1] First shipment made in July, 1935.

LIMES.

During the past few months important developments have taken place in the lime oil marketing arrangements to which reference has already been made in this Journal.* In the past the marketing of this product has been done separately by a large number of producers in the Islands and in British Guiana. Competitive selling often took place with the result that recently prices dropped seriously. Early this year various suggestions were made as to how this competitive selling might be avoided and at the meeting of the Fruit and Vegetable Council held in St. Lucia in April a definite scheme was put forward and discussed. This scheme was referred back to the interests concerned and after several conferences between representatives of Trinidad and St. Lucia, was finally accepted.

* September, 1935.

The lime oil producers in Trinidad and St. Lucia respectively have become members of local associations and have agreed to place all the oil they produce at the disposal of their associations for sale. Each island association has in turn become a member of the West Indian Lime Oil Sales Company which will undertake the selling of the oil of its members. By this means oil instead of being offered by numerous parties will be sold through one association. It is hoped that other Colonies will become members of the Sales Company in due course.

This is the first attempt to bring about the co-operative marketing of a product grown by a number of islands in the West Indies and its progress will be watched with great interest. The promoters of the scheme are to be congratulated

on their achievement and it is possible that a similar organisation will be set up for the marketing of other crops grown in the West Indian Islands.

Green Limes.—The demand for green limes in the United States of America and in Canada has not been as heavy as in recent previous years but the prices realised have on the whole been more satisfactory. This latter has been brought about largely as the result of the efforts made by the Dominican delegates at the Fruit and Vegetable Council meeting referred to above. The suggestion was then made that Dominica should from time to time inform the other Islands by cable of the price accepted for the shipment to be made by the first North bound steamer. This arrangement worked satisfactorily and prevented a slump in prices towards the end of the season when losses were previously so often experienced.

The Montserrat Vegetable Industry.

At present Montserrat is the chief exporter of vegetables in the Windward and Leeward Islands. The report of the Government Marketing Depot indicates that the vegetable season of 1935 was successful and anticipates greater expansion in the next season.

The time of tomato cultivation is so arranged that the bulk of the crop is produced beween February and June when the Bahamas crop is completed and better marketing prices are obtainable in Canada. This arrangement necessitates cultivation in the dry season when conditions are sometimes too dry for high yields to be obtained. The average yield of tomatoes per acre during the season was a little under 4,000 lb. and the average net price to the grower 2½ cents per lb. The Marglobe variety is cultivated. Two-thirds of the Island's production of tomatoes were marketed co-operatively through the Government Marketing Depot. The details of the shipments to Canada are given in the following table :—

Date of Shipment.	Weight shipped in lb.	Net return cents per lb.
Jan., 22nd	1,483	2.3
,, 29th	2,850	2.3
Feb. 12th	11,622	3.1
,, 19th-Mar. 9th ..	51,856	2.1
Mar. 19th	32,633	2.7
April 2nd	44,873	2.5
,, 9th	18,259	2.0
,, 9th	9,576	2.3
,, 23rd	39,821	2.1
May 7th	31,069	2.0
,, 12th	10,362	2.6
,, 26th	13,349	3.2
June 9th	6,706	2.6
,, 16th	941	2.8
,, 30th	1,039	2.5

The cultivation of carrots is also being extended. This vegetable is being used increasingly as an article of diet among the peasantry and the rejects are fed to horses, cattle and pigs.

Exports of vegetables during the 1935 season are given in the following table :—

Government Market Depot and Total Island's Exports during 1935 Season.

Crop.	Shipments made by G.M.D. (crts.)	Shipments made by other Exporters (crts.)	Total Shipments (crts.)	Remarks.
Tomatoes	13,255	5,309	18,564	B.W.I. shipments included.
Carrots	1,569	1,150	2,719	do. do.
Onions	125	397	522	All to B.W.I.
Sweet Potatoes	110	386	496	All to Canada.

Derris or Tuba Root.

Much interest has recently been aroused, especially in the U.S.A., in this plant owing to the presence in its roots of certain chemical compounds possessing toxic properties. Chemical investigational work by the U.S. Department of Agriculture has indicated that there are considerable possibilities for derris root as an insecticide, provided the roots contain a sufficient proportion of a substance called rotenone. There is a large demand for insecticides of organic origin which will lose their poisonous properties in a reasonable period of time after application. Insecticides of this type may be applied to such crops as vegetables, to which the application of arsenical insecticides is considered unsafe.

The demand for derris root has stimulated the cultivation of the plant and multiplication plots of more than one species have been established in St. Vincent, St. Lucia and Dominica. In the latter island cultivation is being undertaken on a commercial scale on one plantation. A large proportion of the planting material has been supplied by the Trinidad Department of Agriculture through the Plant Quarantine Station.

The plant is a semi-climbing shrub, some species more erect, some more trailing than others, and is a native of the tropics. Propagation is effected by stem cuttings 10 to 15 inches long, spaced at 2 × 2 feet to 3 × 3 feet. It is claimed in Malaya that hilly land should not be chosen owing to liability of soil erosion and the risk of water shortage but the soil should be of a good friable type conducive to root development and ease of harvesting. Harvesting the roots is undertaken at from 18 to 22 months after planting.

Arrowroot.

The arrowroot crop in St. Vincent for the year 1934-35 amounted to approximately 34,000 barrels (220 lb.) representing an increase of about

nine per cent. on the crop of the previous year. Exports also are higher than during the corresponding period last year. The young crop is making good progress. The value of sulphate of ammonia as a fertilizer for arrowroot in St. Vincent as determined by recent experiment is more generally appreciated and its application to the new crop has been more extensively practised. Attention is being paid in the matter of improvements to arrowroot factories with the object of increasing the efficiency of extraction of starch.

* * *

Coconuts.

The following table gives the exports of coconuts for the year 1934 :

Island.	No. of nuts.	£ Value.
St. Vincent	979,988	2,538
St. Lucia	2,616,175	7,298
Dominica	103,639	..
Antigua	400	..
Trinidad	9,850,299	29,128

Brevities.

Mr. G. A. Jones, Commissioner of Agriculture, visited St. Lucia and Dominica in July.

* * *

Mr. C. C. Skeete, Assistant Commissioner of Agriculture, visited Antigua, Montserrat, St. Kitts and Nevis in July.

* * *

Mr. E. G. Taylor, Manager of the Government Marketing Depot, Dominica, was granted vacation leave from 1st July to 9th September, 1935.

Mr. S. A. Schouten, Agricultural Assistant, Dominica, has been transferred to Montserrat as Agricultural Assistant and Science Master of the Grammar School.

* * *

Capt. H. V. Metivier, Government Veterinary Surgeon visited St. Lucia from 5th to 8th of June, with the permission of the Trinidad Government, to advise on veterinary matters.

* * *

Mr. H. L. Manning, Agricultural Assistant and Science Master of the Grammar School, Montserrat, has been transferred to the appointment of Agricultural Officer in British Honduras. Mr. Manning leaves Montserrat on 9th October to take up his new appointment.

* * *

Beginning in June, several shipments of the giant toad (*Bufo marinus*) were sent from Trinidad to St. Vincent on the recommendation of Dr. J. G. Myers. An attempt is being made to establish this toad in St. Vincent for the purpose of assisting in the control of insect pests.

* * *

Mr. P. E. Turner, Adviser in Sugar-cane Experiments to the Commissioner of Agriculture, spent two weeks each in Antigua and St. Kitts in July, for the purpose of reporting on the progress of the sugar-cane experimental work and advising on the work to be laid down for the years 1935-37.

* * *

Mr. C. Rex Stollmeyer, Trade Commissioner in Canada for the British West Indies (Eastern Group) paid a visit to the Islands during June, July and August. He held interviews with the agricultural officers and leading members of the fruit and vegetable industries in the various Islands, and, in Trinidad consulted with the President of the Fruit and Vegetable Council (Eastern Group) and the Director of Agriculture.

A TEST OF GREEN MANURE CROPS.

In the *Philippine Agriculturist*, Vol. XXIII, pp. 543-48, C. S. Alonso describes an experiment, the objects of which were (*a*) to discover the comparative values of nine green manure crops in the Philippines, (*b*) to determine the quantity of dry matter they produce, (*c*) to analyse them for values of N_2 and P_2O_5 in the different stages of growth and development under field conditions. The species used were *Tephrosia candida, T. noctiflora, Crotalaria juncea, C. usaramoensis, C. anagyroides, Indigofera hendecaphylla, Phaseolus aureus, Vigna sinensis, Calopogonium mucunoides*. Most of the information obtained is tabulated under the following heads. (1) Number of days from sowing to flowering and to maturing. (2) The average length of roots and stems and the yield of fresh matter in kilograms per square mile. (3) Results of turning under green manures to a depth of 30 cm., examined at 14-day intervals. (4) Relative chemical composition in terms of percentages calculated on oven dried samples. (5) Comparative yields of fertilizing materials calculated in grams per square mile of fresh matter. The records are shown for every month of growth from 2 to 6 inclusive except for *Vigna sinensis* which was from 1 to 2½ months. Table 3 shows that within four weeks the green manures turned under had all been eaten by white ants with the exception of *Calopogonium mucunoides* and *Indigofera hendecaphylla*. Further tests indicated that these plants were definitely distasteful to the ants. *Indigofera* has to be buried more deeply than the others or it will sprout and root again. *Crotalaria usaramoensis, C. juncea* and *Tephrosia candida* are high nitrogen yielders. *Calopogonium mucunoides* was a low yielder for 3½ months but the highest at five months. *Indigofera hendecaphylla* was low in nitrogen throughout. Large quantities of phosphorus were found in all plants at the ages of four to five months.—(*Imp. Bur. of Fruit Prod. Hort. Abstracts*. Vol. V, No. 1. Abs. 139, p. 52, 1935.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Antiscorbutic value of Alfalfa.—L. F. Levy and F. W. Fox, *Biochem. J.*, 29, 884-8, Apr., 1935.

Alfalfa is an excellent source of vitamin C. The concentration in the average leaf is about four times that found in citrus fruit juices. This was indicated first by the indophenol reaction and then was confirmed by biological test. Although the original activity rapidly diminishes when the cells are damaged, preliminary experiments indicate that much of the vitamin remains after cooking, and that it is possible to dry the plant in such a way that alfalfa meal of high activity can be obtained. Since alfalfa is also rich in vitamins A and E and is also unusually rich in minerals such as Ca and Fe, the possibility of using certain types of the young plant as a human food, either as a green salad, cooked like spinach, or in the form of a dry meal is worthy of consideration.—(*Journal of Chemical Education*, Vol. XII, Aug., 1935, p. 394.)

* * *

A Paradoxical Metal.

Anon. *Ind. Bull. Arthur D. Little Inc.*, 100, Apr., 1935.—The recent publication of Dr. Henry G. Knight, of the U.S. Bureau of Chemistry and Soils, on "The Selenium Problem", brings this element to the fore again. The "problem" concerns the occurrence of selenium in certain soils, particularly in semi-arid states such as South Dakota and Wyoming, which causes poisoning of cattle and horses feeding on certain types of plants growing in such soil. The so-called "blind staggers" or "alkali disease" of animals has been traced to selenium which spreads throughout the whole body of the animal but particularly the liver. Fortunately, the wheat raised on seleniferous soils does not run high in selenium and modern milling methods of blending prevent it from being a human problem. The problem of seleniferous soils is a world-wide one, and doubtless needs consideration in Canada, Australia, the Argentine, and other countries with semi-arid soils which are wheat-raising areas. Selenium compounds taken internally or absorbed through the skin cause the whole body to take on a vile odour suggesting horseradish, garlic and brass all at once. Selenium belongs to the sulphur family, and it possesses many of the properties of sulphur. In conjunction with sulphur it imparts resistance to wear in rubber. A most remarkable property of selenium is its ability to suppress the burning of rubber. The telephone companies have a patented exchange wire insulated with this material. A slight smudge of selenium near the bottom of a match made of sulphur (used in testing ammonia leaks) causes the sulphur flame to go out at once when the smudge is reached. This is really remarkable when it is remembered that selenium is sufficiently inflammable to burn under certain conditions. Just recently a patent was applied for for blasting caps made of a mixture of powdered metallic tin and powdered selenium. Sulphur is definitely non-metallic, but selenium may be metallic, or non-metallic. Selenium is used in one type of the "electric eye" and in some of the more recently improved photocells used in relays for turning on lights when darkness comes, for light-signalling, and even for television. Selenium finds a use in the glass industry by producing a red colour common to the automobile tail light and other red glass. It is also used as "bleach" in removing the green colour from glass. (*Journal of Chemical Education*, Vol. 12, July, 1935, p. 346.)

* * *

Vitamin A.

The natural sources of vitamin A are as follows (the figures in brackets indicate the units of vitamin A per ounce, following the system adopted by H. C. Sherman):

Cereals: Bread (3), if made with milk; corn, yellow.

Vegetables: Escarole (6,000); spinach, raw and canned (1,400); carrots (940); peas, raw and canned (175); peppers (175); tomatoes, raw and canned (170); tomato soup (170); beans, string (150); lettuce, romaine (150); broccoli (95); Brussels sprouts (95); artichokes (8); peas, dried, green (85); potatoes, sweet (85); lettuce, head (50); asparagus (35); squash; eggplant (20); beans, navy, canned (15); cauliflower (15); celery, bleached (11); cabbage, new, green or white (10); cucumbers (10); potatoes, white (10); beets (5); turnips (5); cabbage, sauerkraut (5).

Axtmayer and Cook (1933) in their study of the foods of Puerto Rico have determined the vitamin A content of various foods in terms of units per gram. The figures given for the foods following have been converted to units per ounce (28.3 grams): mamey (1134), red pepper (935.5), string beans (283.5), okra (170), arracacha, (113), pigeon pea (85), squash (56.7), cassava (14.2), egg plant (9.4).

Fruits: Mango (840); boiled green plantain (567); prunes (300); bananas (100); dates (85); grapes (20); oranges (20); apples (15); figs, cooking (10); cantaloupes (5).

Dairy Products: Butter (1,400); cheese, cream (1,400); cheese, Parmesan (700); eggs (550); milk, dried, whole (500); milk, condensed (140); milk, evaporated (140); milk, whole (65); cheese, cottage (30).

Meats and Fish: Liver (2,800); kidney (230); fish, fat (10); bacon (5); meat, average muscle (5).—(*J. Chem. Education*, Vol. 12, August, 1935, p. 358.)

CITRUS ROOT STUDIES IN TRINIDAD.

A Preliminary Investigation on Grapefruit.

By E. J. Gregory.
(*Department of Agriculture, Trinidad*).

The rapid development of the citrus industry in Trinidad has called for a systematic study of the growth habits of the crop under the particular conditions of soils and climates pertaining to the Colony. Much preliminary work has already been done especially with regard to nursery practice and the prevention and treatment of diseases (1), (2), (3), (4), (5), (6) and (7). In addition to the series of experiments (8) laid out at the St. Augustine Experimental Station detailed investigations are being carried out by the Department of Agriculture and the Imperial College of Tropical Agriculture regarding the requirements and effects of manurial treatments on various soil types in Trinidad. It is generally recognised that citrus trees in Trinidad require some form of fertilizer treatment but the exact manner of its application is open to question. In this investigation preliminary studies at St. Augustine are described regarding one aspect of this problem.

For the purpose of the investigation four three-year old 'Marsh' grapefruit trees budded on sour-orange stock were excavated in order to expose the complete root systems. Two of these trees had received a complete manurial dressing of nitrogen, phosphate and potash plus pen manure, and cultivation consisting of hoe-weeding and forking each year since planting. The other two trees received no manures and only two cutlassings per year. Three-year old trees were selected as being representative of the age of a large proportion of the citrus planted in the island. The fertilisers had been applied in a ring round the trees just inside and outside the edge of the branch spread, a fairly common practice in the island at present.

The accompanying photographs give a good indication of the spread of the root systems and the network of feeding roots. A rod marked in six and 12-inch lengths gives a comparison of the root spread and the spread of the branches. Figures 1 and 2 show the manured trees, and Figures 3 and 4, unmanured trees. It is clear that the root systems of the manured trees are far more vigorous and extensive than those of the unmanured.

Results of growth measurements (9) of comparable trees in the same area have shown an increase of 100 per cent. in growth increment of manured trees against unmanured trees for height, girth, and spread of the branches. Actual measurements of the roots show that while the manured trees (Figs. 1 and 2) have several lateral roots which exceed the average spread of the branches (42 inches from the trunk), the majority of the feeding roots are shorter and occur at a distance of three to 18 inches from the trunk.

The lateral roots of the unmanured trees (Figs. 3 and 4) on the other hand are shorter but their main feeding roots are situated between three to 12 inches from the trunk, the average spread of the branches in this case being 23 inches.

It appears that the manured trees are not receiving the fullest benefit from the manures applied to them, and that an even greater contrast between manured and unmanured would have been apparent had they been applied nearer to the trees.

It is recommended therefore, that for young trees fertilisers should be spread evenly over a wide circle starting about three inches from the trunk (so that they do not come in contact with the trunk and crown roots) and extending to the limits of the spread of the branches. This area must be clean of weeds at the time of application and the surface soil worked, so that the fertilisers are not washed away by heavy rain.

It is hoped to extend this type of work to cover other aspects of root growth and development.

The author is indebted to Dr. Briton-Jones, who suggested to him the need for this preliminary investigation, and also for valuable criticism of the original draft.

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FIGS. 1 AND 2. *Root Systems of 3-year old 'Marsh' Grapefruit Trees. Complete Manurial Treatment.*

FIGS. 3 AND 4. *Root Systems of 3-year old 'Marsh' Grapefruit Trees. Unmanured.*

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

The "Saturascope": for determining the Temperature to which Massecuite can be heated without dissolving Sugar.—*W. L. McCleery.*

Coincident with the warming of low-grade massecuites came the question of the temperature to which massecuite could be heated without dissolving sugar, (*i.e.*) the saturation temperature of the mother-liquor in a massecuite. Methods for determining saturation temperature, used by Saint in Barbados * and Harman in Australia †, were not found satisfactory. W. E. Smith of C. Brewer & Co., Ltd., suggested constructing an apparatus using an electrically heated air cell and naming it a "Saturascope", and a simple instrument of this type was developed at this Experiment Station. A number of them were made up and distributed to practically all factories. These instruments are now a part of the low-grade massecuite control at most factories.

The "Saturascope" may be used to as good advantage in factories that dilute as in those that warm massecuites. It offers a valuable guide in estimating the proper density to which heavy massecuite should be diluted. It has been found that for every 9°F. (5°C.) rise in temperature and for approximately each one per cent. total solids (or 1.2 to 1.5 Brix) decrease in density, the viscosity decreases 50 per cent.

It has also been discovered that if massecuite of moderately high density and cooled to air temperature is heated to the saturation temperature, as determined at the end of an approximate 5-day crystallization period, it will have a viscosity sufficiently low to permit satisfactory drying. Crystallization is continuous as long as there is supersaturation, so the longer a massecuite "cures", the lower the saturation temperature drops. At the end, for instance, of a two weeks' crystallizing period, the saturation temperature would probably be so low that if the massecuite were heated only to that temperature it would be too viscous to dry satisfactorily. Thus if the saturation temperature is determined at the end of five days' crystallizing period, the density equivalent to heating to the saturation temperature can be easily calculated, regardless of the additional time the massecuite is in process.

Suppose a massecuite has cooled to 85°F. and is to be dried at this temperature. The density is 100° Brix, and the saturation temperature at the end of five days' crystallizing time is 112°F. As previously stated, we know that if the massecuite were heated to the saturation temperature or about 112°F., the viscosity would be reduced enough for good purging, that is, the temperature of the massecuite would have to be raised from 85° to 112°F., or 27°F. A 9°F. increase in temperature would reduce the viscosity 50 per cent.; also a decrease of 1.2 to 1.5 points in Brix likewise would reduce the viscosity 50 per cent. To obtain the same reduction in viscosity by dilution, as by raising the temperature 27°F., it is necessary to add sufficient water to dilute to:

$$100 - \frac{27}{9} \times 1.2 \text{ Brix or } 100 - 3.6 = 96.4 \text{ Brix.}$$

Therefore, if this massecuite were diluted to 96.4 Brix at 85°F., it would have approximately the same viscosity as if it were undiluted but heated to the saturation temperature of 112°F.—(*Inter. Sugar Journal*, Vol. XXXVII, No. 439, p. 279, 1935.)

* * *

Dry Molasses Product. *Harry C. Reiner*, U.S. Patent No. 1,995,519; 26th March, 1935.

To overcome the hygroscopicity of dried molasses, the dried product is intimately mixed with a pulverulent inorganic material such as calcium carbonate. In the practice of the invention use is made of a drying apparatus of the spray-evaporator type, in which liquid molasses is converted into a solid in one operation. In carrying out the drying the liquid molasses is suitably diluted with water to overcome its natural viscosity heated to about 190°F and sprayed under pressure into the evaporating chamber. In this manner the liquid is atomized into very fine particles, which are quicky deprived of their moisture by a current of warm air circulating with cyclonic effect through the evaporating chamber. Meanwhile the pulverulent inorganic material, which may be pulverized air calcium carbonate, is blown into the evaporating chamber, with a similar cyclonic effect. The particles of calcium carbonate thus come into intimate contact with the molasses particles the resulting mixed product is non-agglomerative and non-hygroscopic, remains in a finely-grained, powder-like state and may be stored for a considerable period of time without deterioration of its powdery characteristics, and without impairment of its value as a stock feed.—(*Facts about Sugar*, Vol. 30, No. 8, p. 308, 1935.)

* * *

Action of Acid Sugar Syrup on Various Metals. *By C. Johnston.*

Samples of the metals mentioned in the table below were immersed in 250 mls. of a pineapple syrup which had been brought up to a density of 36° Be. by the addition of sugar. The area of the metal plates was approximately 100 sq. cms., and the figures stated express the loss per sq. cm., the time being six weeks.

Aluminium..	0.000077
Stainless steel	0.000060
Nickel	0.000145—

(*Chemistry and Industry*, 54, No. 15, p. 342, 1935.)

* *I.S.J.*, 1933, p. 234.
† *I.S.J.*, 1933, p. 261.

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.) :—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
25th July	4 2¼	7 11¼
1st August ..	4 5¼	8 2¼
8th August ..	4 5¼	8 9¾
15th August ..	4 4½	8 1½
22nd August ..	4 4¾	8 0¾
29th August ..	4 3	8 0
5th September ..	4 3¾	8 0¾
12th September	4 3	8 0
(*13th September*, 1934)	4 5½	8 3

The main feature of interest was the announcement of H.M. Government's long term policy which provides for the continuation of assistance to the Beet Industry without any limitation of the period during which assistance may be given. This definite settlement of Great Britain's sugar policy ended a period of many months of doubt and uncertainty and was met by a favourable response from the market which early in August showed increased activity in both Whites and Raws. This activity has since abated and a quiet tone again prevails with only moderate business passing.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	Pence per lb.
31st July	5 13-16
7th August	5 7-8
14th August	5 11-16
21st August	5 11-16
28th August	5 5-8
4th September	5 9-16
11th September	5 9-16
(*12th September*, 1934)	7 1-2

The market has been very quiet with a drooping tendency. There has been a fair amount of liquidation of the September position and, with considerable nervousness caused by the European situation, prices have suffered to the extent of 3/16*d.* per lb. The *American Questionnaire* figures for July were better than generally expected, the consumption of rubber being 4,000 tons higher than had been estimated. News from America continues good particularly as regards the tyre and motor trade.

* * *

COCOA—During the past month the market has been quiet and the price of Accra if anything is rather easier. More interest was shown by manufacturers for this description both for early delivery and for new crop, and it is quite possible that some of the Continental manufacturers have been influenced by the political situation. Accra is quoted at 21*s.* 6*d.* c.i.f. and locally at $5.60 a fanega.—(*By Courtesy of the Cocoa Planters Association of Trinidad, Ltd.*)

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :

	American Mid.	*Egyptian F.G.F. Sakel.*
26th July	6.80	8.07
2nd August	6.68	8.09
9th August	6.48	8.10
16th August	6.56	8.18
23rd August	6.33	7.99
30th August	6.25	—
6th September	6.11	—
13th September	6.21	—
(*14th September*, 1934) ..	7.10	8.32

The first American crop statistics for the 1935-36 season revealed that production would be somewhere over 11½ million bales. These figures were regarded as decidedly bearish and prices in Liverpool and New York have tended to decline. Another disturbing factor in the market at the moment is the political situation in Europe. There has been a fair inquiry for West Indian Sea Island but only a few sales have been reported, the latest quotations being 15*d.* to 18*d.* per lb.

* * *

GRAPEFRUIT.—The imports into the United Kingdom for the fortnight ended 27th July amounted to 56,733 cwt. consigned by the following countries :—

Jamaica	89
South Africa	27,283
South Rhodesia	386
Portuguese East Africa	1,838
United States of America ..	24,464
Puerto Rico	263
Brazil	1,566
Argentine	841
Other Countries	3

—(*West India Committee Circular*, 15th August, 1935.)

* * *

BANANAS continue in good demand, with Jamaicas unchanged at £18 5*s.* per ton delivered. London and £18 nearest station. Brazilians are also unchanged at £18 nearest station. The imports into the United Kingdom for the fortnight ended 27th July amounted to 1,028,056 bunches consigned by the following countries :—

Jamaica	804,650
Gold Coast	560
Canary Islands	19,351
Brazil	67,283
Colombia	113,190
French West Indies	23,000
Other Countries	22

(*West India Committee Circular*, 15th August, 1935.)